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Electrical Execution. WE give in another column a few words about the apparatus used in the electrical execution at Auburn prison. We have no sympathy with the ghoulish curiosity that seeks harrowing details of an event that should be regarded as an unfortunate and painful necessity, but in the interest of electrical science we shall give such facts as may be of value as showing the action of fatal electric shock on the human body. We have therefore published accurate information concerning the electrical details of the apparatus, and in addition give some account of an early accident, from an alternating current, which, by reason of the careful investigation it provoked, may be useful for reference when the scientific and medical facts pertaining to the Kemmler execution are made public.

Street Railway Construction. THE early electric railroads were an example of the difficulty of applying old constructions to new conditions. So long as poles were only used to support telegraph and electric light wires, and were subjected to no severe lateral thrust or pull, the time-honored wooden pole answered well enough. But when the electric railway appeared with cross wires under severe tension, something better had to be devised. Any one who has seen an electric railway, put up with ordinary telegraph poles, after a year or so of service, can appreciate the state of affairs most thoroughly. If an overhead trolley wire is to be kept taut and the system is to look neat in a city street, iron poles are to-day almost a necessity. We give this week a cut and description of a wrought-iron pole that seems to have withstood quite severe tests, and to be admirably fitted for the needs of a city railway where great strength must be combined with a neat appearance of the overhead construction.

The Lighting of the "Majestic." No steamer has ever received a more appropriate name than the White Star Line's new racer, which is not merely a big boat, or a fine boat, or a fast boat, but is also really a majestic vessel. This is true, from the united grandeur and simplicity of her lines, as well as of her decorations, when she is seen by day and close at hand; but it is still more true by night, when, seen from any viewpoint, the great ship stands out against the darkness, a living mass of brilliancy. We give this week a series of illustrations showing the apparatus by which the 1,200 lights on board the "Majestic" are supplied with the electric current. The arrangements for sea lights have been carried to a high degree of perfection by the Belfast builders, and, although they have used no such startling effects in decoration as distinguished the "Puritan's" cabins, shown in THE ELECTRICAL WORLD some time ago, they have certainly produced a model of the effective use of electric light at sea.

He Does Not Love Experts. HIS Honor the Mayor is wofully perturbed. His gentle spirit has been deeply grieved by the reluctance of the electric companies to entrust their cables to the hot subways down town; and when, the other day, Dr. Wheeler ventured to submit, in addition to his own opinion, the evidence of several other experts, in the case of heat *vs.* insulation, the official wrath broke loose. In a burst of peppery indignation, his honor, in the choicest vernacular at his command, declared that he wouldn't have such a report on any terms, and very forcibly conveyed the idea that he had no use for experts who could not, or would not, indorse the official superheated subways. Considering Dr. Wheeler's high reputation in electrical affairs, and his good record in filling a very difficult position, the Mayor's denunciation of his report is anything but justified. The added evidence of other experts should have given weight to the opinion of Dr. Wheeler, instead of arousing a tempest of wrath that, to say the least, was undignified.

Pyroelectric Batteries. A FEW years ago a spasmodic interest was excited in a method of producing electric currents that depended for its operation on the chemical action stimulated by intense heat. In his recent note in the *Comptes Rendus*, M. Becquerel gives a brief sketch of the various forms assumed by the pyroelectric battery in various stages of its development. What is more important, he calls attention to the fact that such a battery is not essentially different from the ordinary liquid cells, but like them depends for economic value on the cheapness of the chemical used. Of course it may be possible by supplying artificial heat to utilize chemical reactions otherwise unavailable, and so by using cheaper materials secure a cheaper source of electricity. Still, so far as yet discovered and the investigations of the question have been numerous—it is impracticable to effect any marked saving in cost of chemicals by such a method of using them. The pyroelectric battery is far from being a direct means of transforming heat into electricity—it is only a phase of the primary battery, which, although possessing certain advantages, gives little promise of cheapening the production of electric currents.

Gas Light and Gas Engine. A COMMUNICATION printed in another column raises again the very interesting question of domestic lighting by the combination of gas engine and dynamo. The problem of efficient artificial lighting is not an easy one, and it is not encouraging to remember that the most economical means yet devised for converting the latent energy of coal into light has an efficiency of but one per cent But some consolation and evidence of advancement may be derived from the fact that while the arc lamp has only the feeble efficiency just mentioned and the incandescent lamp barely half that small figure, yet gas and kerosene, oil and tallow dip, are far below electricity as economical means for producing light. So our correspondent's points are well taken, when he calls attention to the gain in substituting a good method of producing light from mechanical energy for a bad method, even when the former involves an additional transformation. Electric lighting by gas engines has an additional advantage in regions where natural or fuel gas can be obtained, and there is a wide field for the successful commercial application of a process which is alike theoretically efficient and practically economical.

Life of Incandescent Lamps. VERY encouraging figures are those reported in another column concerning the life of the lamps in the office building plant mentioned in a recent issue. The monthly account of coal consumed and lamp hours burned is good food for reflection. It is, of course, difficult to deduce the exact life of lamps from the monthly breakage account, even when these extend over two years; nevertheless the approximation reached is probably quite close, especially when we take under consideration the actual results realized during the second year. The amount of coal burned to furnish a lamp hour is also a quantity to be carefully noted, for, as the ratio of cost of fuel to entire expenses is a quantity that can be judged very closely, the figures given are a good basis for estimates on similar plants. The day is coming when the flickering and ill-smelling gas light will be a thing of the past, wherever there is a chance for an economical electric plant. Up to the present time, high cost is the only thing that has stood in the way of general electric lighting, and it seems as if that objection were on the point of final removal. Certainly, with the examples of economy we now have, few large buildings will in the future be lighted with gas.

Electrical Distribution. As electric lighting becomes more and more universal, and complicated networks of wire are woven about great central stations, the need of careful study of the most efficient and economical distribution of the copper becomes most apparent. The paper in the present issue, very courteously forwarded to us by the authors, treats the subject very neatly and simply. The mathematical processes involved in the computation of a network, according to Kirchoff's laws, are too abstruse for ordinary use, so that a simpler and more practical treatment of the problem is doubly welcome. The fundamental idea of Herzog and Starks's valuable discussion is the principle of moments and the electrical center of gravity of a system. This well-known principle is carefully developed for application to some of the practical cases that arise in everyday work. With the increasing use of motors, producing a demand for current that varies and shifts from place to place with startling rapidity, the network of supply must be designed with the greatest care if good service and economy are to be secured. This will become of more and more importance in this country as the price of copper rises, which is a probability of the near future, unless the present tariff is modified.

Gas and Subways. THE recent meetings of the Senate committee have brought out some rather startling facts about the condition of the gas pipes in portions of the city. It is an unfortunate fact that gas mains and subways do not get along well together, and when their differences are augmented by the interference of hot steam pipes, it is time for vigorous action. The fact is that the combination of heat and escaping gas is too much for any ordinary form of insulation. Besides this there is always danger of explosion in a subway when it is filled with an explosive mixture of air and gas. Of course the gas companies emphatically deny the existence of any serious leaks; but the evidence presented that a hole punched in the earth by a crowbar will sometimes leak gas enough to burn very readily lends a farcical appearance to their protestations. Truth to tell, the streets in the lower part of the city are so filled with pipes and conduits of various sorts that only extraordinary precautions can avert serious trouble. Rights granted to the gas companies to pipe the streets do not give them free permission to let the gas pour through the rickety joints to damage the property of other companies having underground mains, and endanger the innocent public. The electric companies have a task quite severe enough in trying to maintain efficient service underground without their most earnest efforts being rendered unavailing by escaping gas. The whole subject of the complex system of underground conduits necessary in a great city needs thorough overhauling. No half-way measures can afford relief. Radical and sweeping reforms are necessary here and now, else the whole matter will hasten from bad to worse.

The Telephone vs. the Electric Railway. THE decision of Chancellor Gibson, which we present on another page, refuses to enjoin the use of the single trolley railway system in the streets of Knoxville, and denies the right of the telephone company to the exclusive use of the ground upon which the city is built as a return conductor. This decision is in sharp opposition to that of Judge Taft in Cincinnati, given in our issue of March 1, but follows the reasoning in the earlier cases in Eau Claire and Harrisburg. The fundamental reason for Judge Taft's opinion was that the telephone companies have invested large sums of money on the supposition that their system would not be interfered with; but Chancellor Gibson sees in this argument a danger that all advance be checked, and is unwilling to apply a ruling of law that would make the development of future means of locomotion dependent upon the will of a private corporation. Highways, he holds, are avenues of traffic, and only secondarily ways for telegraphic and telephonic correspondence; the chancellor, therefore, refuses to believe that the city of Knoxville, in granting a license to the telephone exchange, had any intention, if indeed it had the power, of estopping its citizens from subsequently utilizing their streets for any means of traffic and intercommunication that future inventive progress might develop. The present decision will hasten the adoption of the complete metallic system for telephone purposes; and, as we intimated at the time of Judge Taft's decision, this is a consummation as desirable as the devising of a cheap and serviceable double trolley system for electric railways. The divergent decisions of the courts may thus be a blessing in disguise; in some places ingenuity will bring forth better railway systems, while in others the law will force telephonists to discover improved methods in their specialty.

The Apparatus for Electrical Execution.

So much has been said concerning and so many unauthorized and inexact descriptions have been published of the apparatus prepared for the first electrical execution, that a simple statement of the facts may be of interest to the readers of THE ELECTRICAL WORLD.

Of three equipments for killing by electricity procured by the State, the first to be employed is, as is well known, that at the Auburn prison; and to that particular case our description applies. The apparatus we may classify under three heads; first, the source of electricity; second, the means for applying the electric current to the unfortunate prisoner; and third, the accessories that have been deemed desirable.

The dynamo at Auburn prison presents no startling or remarkable features—it is not a "whirling implement of death," but an ordinary alternating current dynamo, such as is generally used for incandescent lighting. Previous to its being purchased for its present unpleasant task, it was in use in Oneonta, N. Y. It is a Westinghouse machine of the pattern manufactured several years ago, and was designed to supply 650 incandescent lights. Like other machines of its class, its field magnets are excited by a small direct current dynamo, driven by a separate belt. The electromotive force of the large machine can be regulated nicely by varying the current supplied from this exciter. When both machines are driven at normal speed and the field magnets of the alternator are fully charged, the electromotive force across its terminals is considerably in excess of 1,000 volts. As arranged at Auburn prison, however, the alternator is driven at about 1,450 turns per minute, and the exciter at 2,100. Under these conditions the electromotive force of the alternator is reduced to 1,050 volts approximately. It should be remembered that this figure is the mean electromotive force, and that, as in all alternating current dynamos, the maximum voltage is considerably higher. If the varying voltage followed the theoretical curve exactly—a sine curve—the maximum would be 12 times the average voltage, which latter is alone referred to in estimating the commercial voltage of a machine. In the case of the dynamo under consideration the electromotive force fluctuates more sharply, however, and the maximum voltage is probably nearly or quite 2,000.

The current generated by this dynamo is taken to the execution room, and by pressing a simple button is connected to the electrodes. These are very simple in design. A rather flat cup of rubber, soft enough to admit of its edges yielding, and a little over four inches in diameter, contains the electrode proper. This consists of a thin circular brass plate, in diameter somewhat less than the cup. Upon this is fastened a layer of elephant's ear sponge to form the actual contact. A rod passing through the bottom of the cup carries the plate. A spiral spring inserted between plate and bottom of cup insures a firm contact when the cup is placed in position. The original plan was to apply the current to the head and feet of the condemned man, but that has been abandoned, and while one of the electrodes above described presses on the top of the head, the other is applied to the spine in the lumbar region, so that the brain and spinal cord are almost directly in circuit. The sponges on the electrode plates are of course wet, and holes in the rubber cups enable them to be filled with water if desirable.

As to accessories, the voltage produced by the machine is measured both in the execution room and dynamo room by Carden voltmeters placed each in series with a special resistance box. As the instruments are ordinarily constructed they do not measure potentials as high as 1,000 volts; thus extra resistance became necessary. As an additional precaution against doubtful voltage, and to serve as an indication that the apparatus is working in its normal way, a bank of twenty-four incandescent lamps is placed in parallel with the victim. These lamps can be successively thrown in series with each other by screwing them in their sockets with a turn or two. This arrangement gives an accurate idea of the total voltage across the mains, since the lamps require a known voltage, and instantly show any decrease by burning faintly. In case the voltmeters fail, as sometimes happens, these lamps are an excellent guide for adjusting the machine. An ammeter in circuit enables one to make a close estimate of the current actually used. Aside from the measuring instruments there is a pair of large switches insulated with extraordinary and needless care, one throwing the lamps into circuit, the other closing the circuit in the mains which lead to the electrodes.

Of the deadly nature of the combination there is not the slightest doubt, but it must be remembered that although the machine employed is similar to those in use for electric lighting, for electrical execution the primary high potential current is used, while for domestic lighting the high potential wire is studiously kept out of houses, and the current actually passing through the lamps is from the secondary of a transformer and has a potential of but 50 volts, an amount which there is every reason to believe is entirely harmless. Even the primary current is practically no more dangerous than that used in ordinary arc lighting. Either will kill if given a fair chance, but both can easily be kept from becoming dangerous to the public.

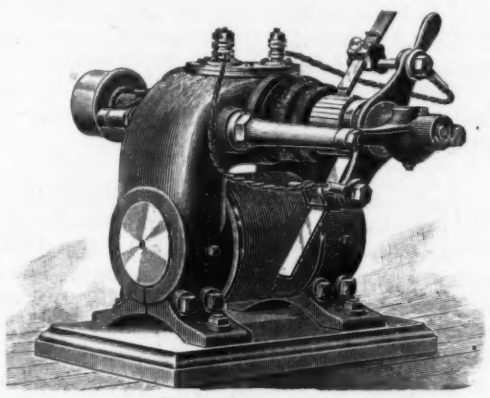
Westinghouse Electric Railway Company.

This company has issued a circular calling attention to some of the merits of its system, and from this it appears that certainly for the present the new company will not use the alternating system, but will enter the field with a constant potential motor for direct currents, designed for the standard potential of 500 volts, and that the over-head system will be used. There are no radical departures from existing methods, but great improvements in details of construction are claimed. It is understood that special care will be taken to make a motor that will require few repairs. The new motors can be operated on any existing line of electric street railway. The dynamos furnished for use with them can be used in connection with those already installed. The company is already making progress, and has even now taken contracts for plants to be completed at an early date.

The Jenney Motor.

The accompanying cut illustrates a three-quarter horse power constant potential motor manufactured by the Jenney Electric Motor Company, of Indianapolis. This is a size not usually listed or furnished, but is found in practice to be very convenient for a large variety of uses.

This motor is uniform in design with the other motors made by this company. Among the advantages claimed for the Jenney motor by its inventor are the shape of pole-pieces, and the method of connecting the wrought-iron magnet core with the pole-pieces. A practically perfect and uniform path is provided for the magnetic lines of force. There are no angles, with their attendant loss of magnetism; and no imperfect joints, with their unavoidable high resistance. Only one field magnet is employed, so that the magnetic circuit is very short. The above features



THREE-QUARTER H. P. JENNEY MOTOR.

give a magnetic field of great strength, which is at the same time very economical to maintain.

A simple shunt winding is used, an automatic regulation of speed being secured without the use of compound winding, thus avoiding the danger of reversing when motor is overloaded. Self-oiling bearings are used on all sizes. The armature, which is of the Siemens type, is wound with care, and thoroughly protected from injury. It is stated that the machine is so wound and proportioned that the neutral point remains fixed under the brushes, and there is no sparking at the commutator, even under extreme changes of load. As an illustration of the durability of this motor, an example is cited of a machine that has been running day and night in Indianapolis for nine months, without a single item of repairs, and with no appreciable wear on the commutator.

Electric Lighting on an Ocean Steamer.

In view of the great interest now taken in the use of electric lights at sea, we give herewith a detailed account of the plant used in a modern steamship, choosing for illustration that of the magnificent new White Star steamer "Majestic," recently in this city on her first trip.

At the start, a few words of description concerning the steamer herself may not be out of place, as, in addition to other interesting features, she may probably be called to public attention during the coming summer by a remarkable showing for speed.

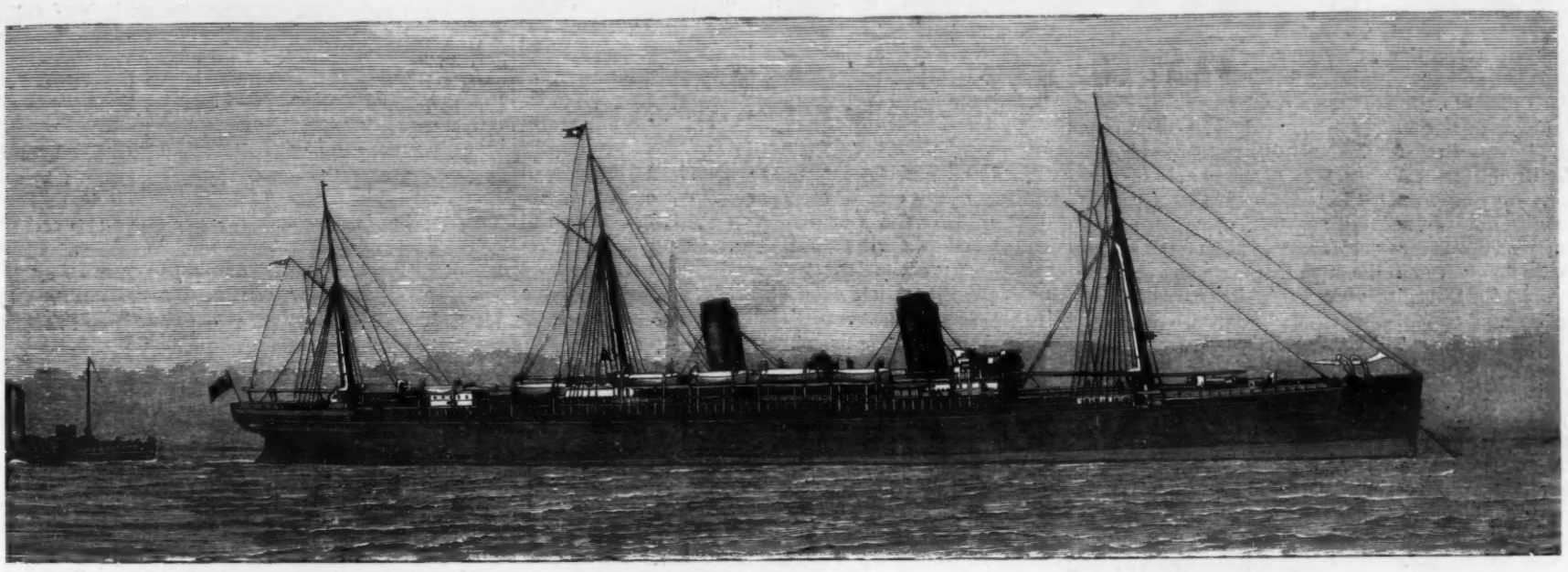
The "Majestic" was built by Harland & Wolff, of Belfast, Ireland. She is 582 feet long, with a beam of 57½ feet, and 39½ feet depth of hold. Her model is very graceful, with particularly fine lines in bow and run, and bears every evidence of having been built for high speed. She is constructed of Siemens Martin steel, and is provided with numerous transverse water-tight bulkheads strongly braced, and, in addition, a longitudinal bulkhead reaching well above the water line and running the entire length of the ship. The "Majestic" is thus divided into a large number of water tight compartments, according to the plan followed in most modern steamers. She is propelled by two different sets of engines, each triple expansion, and capable of handling the vessel in case of break-down, but of course at a reduced speed. There are two three-blade propellers. On the run over the average consumption of coal is reported as only 280 tons; a very low figure when we remember the enormous power of the engines and the speed attained, the best ever achieved on a maiden trip and a far better record than that of the racers of five or six years ago. Like her sister ship the "Teutonic," the "Majestic" has been fitted as an auxiliary war vessel, being provided with mounts for twelve 6-inch rapid-firing guns. With purposes of war in view, too, she was compelled to comply with admiralty regulations, and be free from yards aloft. As to the interior fittings of the ship, comparatively little need be said, as she has been fully described in the daily press. The fittings and equipment are most admirable, the decorations being in singularly good taste, and the whole effect exceedingly striking.

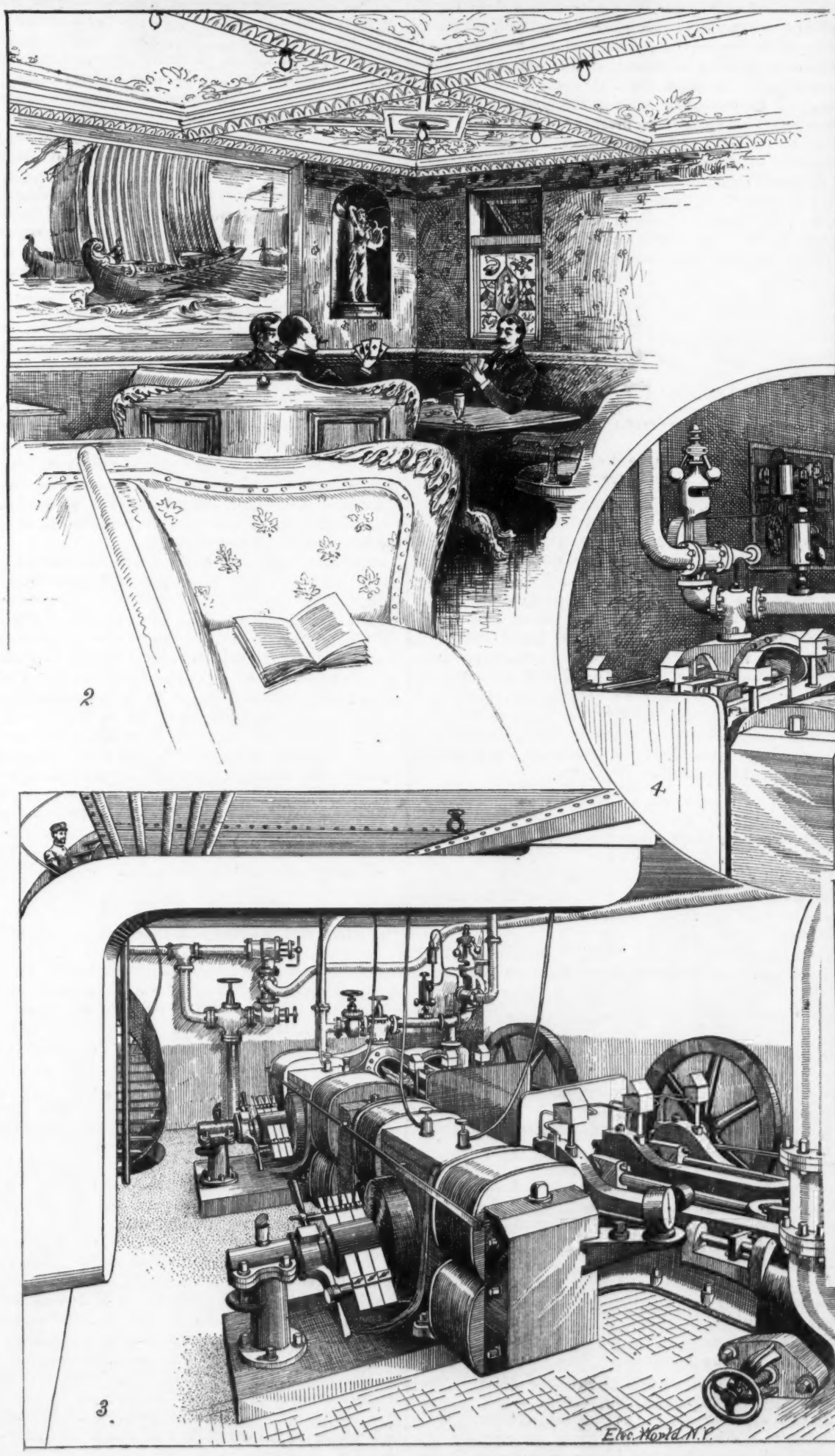
It is with the lighting features of this great steamship that we are most concerned, and to seek for the lighting plant one has to descend deep into the hold. Far down in the after part of the engine room, with three grated iron decks above, are located the two dynamo rooms where the power for lighting is supplied. These dynamo rooms are almost exact duplicates of each other, one of them being on each side of the great longitudinal bulkhead. They are entirely independent of each other, so that in case of accidental flooding of the engine room or the like, facilities for lighting would still be available. In each of the two dynamo rooms are placed a pair of compound wound dynamos, each being driven by an independent engine. The dynamos are of the well-known Crompton type, with a ring armature of large diameter and many sections. Each is capable of producing 240 ampères at 100 volts potential when driven at its usual speed of 192 revolutions per minute. As in all slow speed machines the field magnets are very massive. Square wire is freely used in the winding, a feature unusual in machines designed on this side of the Atlantic. Each of these dynamos is coupled direct to a Tangye parallel compound engine of 7 inch stroke. The high and low pressure cylinders are respectively 8 and 16 inches in diameter. Steam at 180 lbs. pressure is obtained from the main boilers. These engines have cranks set 90 degrees apart, and run with great smoothness and regularity.* Fig. 2 of our cut shows a view of the port dynamo-room exhibiting couplings of engines and dynamos, and the arrangement is the same on the starboard side. Fig. 3 shows the latter, and gives a clear idea of the details. The switchboards, Figs. 5 and 6, are placed as shown in the starboard dynamo-room and in the corresponding corner of the port dynamo-room. The connections are so made that the entire load can be thrown on any one dynamo or any combination of dynamos, so that it would hardly be possible to cripple the lighting plant entirely. From these dynamo-rooms the main cables reach out over the ship, supplying the lamps. The primary lead is a cable of 19 No. 14 B. W. G. wires, while the branch leads diminish in size until the single lamp wiring is done with a No. 18 B. W. G. wire. Instead of having the usual parallel system used on lamps, the ship is used as a return circuit, as is not infrequent in ship lighting. The "Majestic" is wired for about 1,200 16 c. p. incandescent lamps, besides others of 50 c. p. for side and masthead lights. All the wiring is in moldings. Most of the lamps have ground bulbs, although some are of clear glass, and others of clear glass and ground globes. About 1,000 lamps were lighted on the trip over, the load not being thrown on all the dynamos at any one time, but shifted from pair to pair to distribute the work. No electroliers are in use, all the lights being dropped just below the molding, and the carrying wires being plentifully distributed over the ship. In the saloon and dining rooms lights are specially numerous. A corner of the beautiful smoking room is shown in Fig. 4, with the lights on the ceiling and at the sides. The soft light that sifts through the ground glass bulbs produces a beautiful effect on the interior decorations. There is one noticeable difference between incandescent lighting here and that used in American plants. Few of the lamps are provided with key sockets, the English plan being to control the lamps by a group of switches instead. There is an elaborate system of cut-outs, however, special care being taken in this respect.

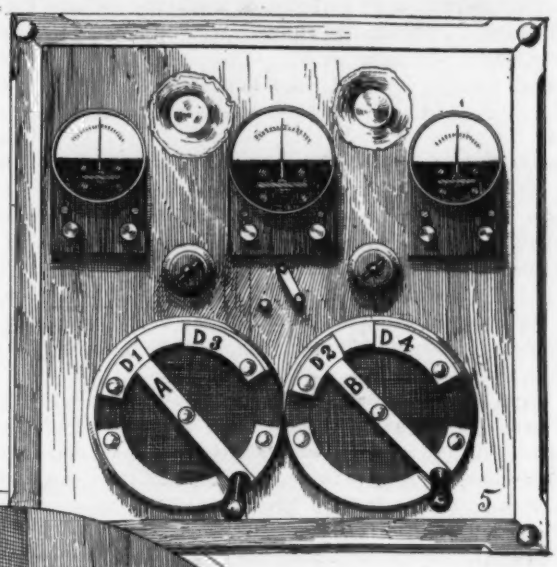
Besides lighting the ship, the dynamos furnish current for a small motor which is used in the barber shop. Other motors might advantageously be used in various positions on the ship, but our English cousins do not seem to have been thoroughly broken into the idea of distributing power freely by this means.

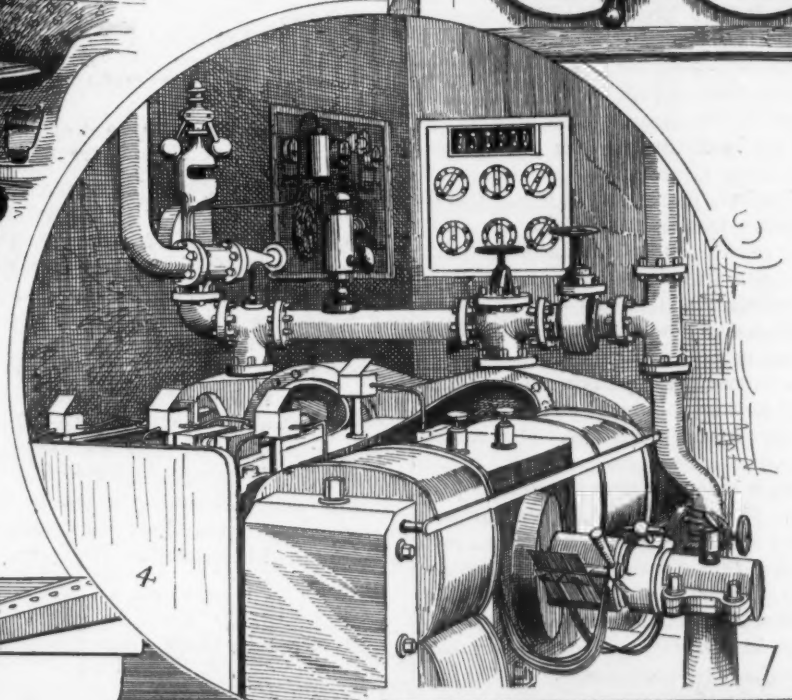
An interesting question might be raised as to whether the wide distribution of electric currents over a ship, that is necessary for extensive lighting, might not produce some effect on the ship's compass. By experience it is shown that there is no trouble to be experienced on this score, the action of the currents being only local and by no means far-reaching enough to disturb the compass needles, which, for other reasons, are located far from any such disturbing cause.

The lighting of the "Majestic" is very complete, and the machinery is reported by the electrician as working with great smoothness, having given almost no trouble on the run over. The arrangement of the lights is not striking nor ornamental, but is very effective. The visitor sees nothing but the little ground glass bulbs scattered freely at every point where light is necessary, all the wire being invisible; and it is only when the current is turned on, and the whole great steamship glows with light, that he realizes the care that has been spent in providing means for so perfectly accomplishing the work.









No 1. THE "MAJESTIC".
" 2 A Corner in the smoking room.
" 3 Port Dynamo room.
" 4 Starboard Dynamo room.
" 5 } Switchboards.
" 6 }

ELECTRICAL FEATURES OF THE NEW WHITE STAR STEAMER "MAJESTIC."

On Death Produced by Electricity.

So much of a sensational character has been written concerning accidental deaths by electric shock that it seems desirable to call attention to the scientific details of a case which, although it occurred in the early days of electric lighting, is remarkable for the careful investigation it provoked. On the 6th of August, 1882, about 10 o'clock in the evening, two young men, in climbing a wall in the garden of the Tuileries, Paris, came in contact with a pair of bare wires carrying the current for twelve Siemens differential lamps. They were found dead in the ditch that ran along the base of the wall. Their bodies were taken in charge by the authorities and careful inquiry was instituted into the exact cause of death. The bodies had received superficial burns from the wires, but both had fallen away from contact immediately. In the case of one a minute autopsy was made by Prof. Brouardel. His report is exhaustive. The internal organs presented an appearance differing from the normal only in showing some local congestion. The condition of the heart and lungs gave, however, evidence as to the mechanism of death, and after detailed examination the conclusions reached were as follows:

"1. The lesions noted at the autopsy are those found after convulsions, provoked by lesion of the bulb.

"2. The furrows observed on the face were produced by a powerful electrical discharge.

"3. Death resulted from this electric discharge. It was due to the shock, and had for its immediate cause arrest of the heart."

The body of the second victim was removed to the military hospital of Gros-Caillou, and there an autopsy, quite independent of the former, was made by Dr. Bourrot. As in the first case, there were no marked internal lesions. The left ventricle, however, had apparently been arrested in systole, and the brain showed distinct signs of congestion —far more than in the previous case. As to the causes which produced death, Dr. Bourrot reached the following conclusions:

"The burns on the hands were produced by the electric wire. The soldier Kenarec probably died from arrest of the heart resulting from a violent excitation of the pneumogastric system; this arrest was not definite at the exact moment of the accident, but the heart could not resume its functions, and immediately following this constraint was produced the asphyxial congestion found in the viscera, noticeably in the nervous centres."

This, too, is definite as to the cause of death, ascribing it to shock and arrest of the heart through the pneumogastric nerve.

Besides these investigations, Prof. Gariel was detailed to examine into the causes and results of the accident, and made an elaborate report to the Tribunal de la Seine detailing the circumstances of the case and the conclusions to be drawn from the autopsies. It was probable that the unfortunate men had received the full difference of potential between the mains at the place of the accident. This was that due to a Siemens' alternating machine that supplied the lamps, and at the point in question amounted to 500 volts. On the cause of death Prof. Gariel gave the following definite opinion:

"But to explain death it is not necessary to suppose any very energetic action. The electricity did not produce serious physical lesions sufficient of themselves to cause death. The burns which appeared were the only immediate consequences of the action of the current, and were not in themselves of any great severity. The electricity acted indirectly by suspending, in part, the action of the nervous system, and this suspension produced death. The action may be compared to that of a pawl, which, released by the slightest touch, may fall upon a toothed wheel and stop a powerful machine."

This statement is amply indorsed by the results of other investigations upon deaths caused by electricity. When a fatal electric discharge is received, the instantaneous death is due to the nervous shock that paralyses the vital functions — the machinery of life is stopped. There may or may not be internal lesions produced by the subsequent action of the current—it is immaterial, the work has been already done.

It is often asserted by ignorant persons that we know nothing of the action of electricity in producing death, because the post-mortem appearances are very similar to those which may be produced by other causes. This fact in reality only means that arrest of the heart may be produced by a violent nervous shock due to causes other than electrical, and that congestion is a frequent concomitant of such a condition.

So it is hopeless to try to predict the exact conditions that give an electric current deadly power—they are not strictly measurable in volts or ampères or ohms—for they depend on the havoc wrought on the nervous system. That in turn may depend on the suddenness of the shock, the rate of variation of the impulses, or the maximum energy of the discharge. In any case we can only fall back upon experience, and say, from the results of many accidental experiments, that while currents of a certain voltage are dangerous, certain others are not. If strictly continuous currents under 500 volts can produce death, it is under very unusual conditions, while it is only too clear that 500 volt alternating currents may, and do, kill; while a vast weight of evidence makes it very clear that any current above 1,000 volts has fatal power, and unless the conditions of contact are distinctly unfavorable, it will produce immediate death.

Board of Electrical Control.

The question of the damage to cables in the down-town subways of the city by the escape from steam pipes has lately engaged the attention of the Board of Electrical Control, and on April 23 the Board met to hear the report of Expert Wheeler, who was directed at a previous meeting to collect data on the subject, and to incorporate into his report whatever pertinent and reliable information he could obtain from other experts.

Mr. Wheeler pointed out the difficulty of making a cable the insulation of which would not be lowered by the high temperature now existing in certain parts of the subways, from the fact that the best insulating materials at present known depreciate exactly in proportion to the rise in the temperature in which they are placed.

Judging from present appearances it would not be feasible to remedy the excessive heat in the subways for months to come. In accordance with his instructions Mr. Wheeler had obtained opinions on the subject at issue from several well-known experts, including Frederick Darlington, electrician of the United States Illuminating Company; E. G. Acheson, consulting electrician of the Standard Underground Cable Company; Prof. H. Morton, Stevens Institute, and others, which were placed before the board. These letters held unanimously that no permanent progress could be made in getting the wires underground until Broadway was torn up, and the present adverse condition of the steam pipes remedied.

On its transpiring that certain of these opinions had come to Mr. Wheeler at second hand instead of directly, Mayor Grant refused to consider the report, and Mr. Wheeler was directed to prepare a new report.

The United States Company were granted permission to place a 12-conductor cable on present poles from 130th street and Third avenue, via 130th street and Fourth avenue, to 135th street and Fourth avenue, in lieu of the cables now in use between those points, which are to be taken down.

The meeting adjourned *sine die*.

An Unusual Form of Contract.

The city of Craïova, in Roumania, is going into the electric lighting question in a very substantial manner. The government has introduced in the national parliament a bill authorizing the city to contract with the firm of Egger & Co., of Vienna, for lighting streets, buildings and residences for the period of forty-five years. The company is to build its own plant and put all wires underground; and the city agrees to use 800 lamps of 16 c. p., and to pay therefor four centimes per lamp per hour. Private consumers are to be charged not more than six centimes per lamp per hour; a centime is equal to one-fifth of a cent. This difference of fifty per cent. in the prices charged seems severe at first glance, but is probably fair enough when the irregularity of private usage is compared with the fixed hours of the city's lights.

Brooklyn Institute—Department of Electricity.

Despite the inclement weather on Saturday evening, April 26th, fully 300 hundred people attended the fifth of Professor Spice's series of lectures at the Institute Hall on "Electrical Measurement."

There are now 80 members of this department. This is truly phenomenal, as the department has been in existence only one month, and it indicates widespread and general interest in electrical science.

Professor Spice's lectures have been a decided success. His demonstrations, by use of a reflecting tangent galvanometer under serious magnetic difficulties, have been remarkably accurate, and much original apparatus has been introduced with gratifying results.

The subject on Saturday evening was the measurement of electromotive force.

Professor Spice stated that the subject was very comprehensive, and one which could not be fully and clearly treated in one evening. He would, therefore, make practical electrical measurements, not theorize the subject, and discuss the matter more in detail at another time.

He explained carefully the distinction between electromotive force and potential, and by means of the Wheatstone bridge and reflecting galvanometer illustrated the difference of potential at different points along a circuit.

He then demonstrated by means of similar large and small cells, that the electromotive force of a given generator depended entirely upon the component parts of such generator, irrespective of size or quantity.

He then explained some of the causes of counter E. M. F. in batteries, and illustrated by means of an especially constructed cell containing two independent copper plates, the effect of hydrogen deposit in producing this E. M. F.

In connection with the ampère unit, the voltmeter was also very clearly analyzed together with the relative merits of silver and copper for deposition. The professor next explained briefly a simple method for calibrating a tangent galvanometer by means of a voltmeter, and also gave a practical illustration showing that the deposition of metal may be largely controlled by the shape of the anode and by its distance from the kathode.

The value of the ohm was then considered, and the effect of heat in increasing resistance, shown by special apparatus.

On Saturday, May 3, the final lecture of this series will be given by the professor, on "The Energy of the Current."

The necessary room for a laboratory for this department has been selected, and it is expected that this valuable adjunct will soon be ready for use.

Priority of Invention in Electric Drilling Apparatus.

To the Editor of The Electrical World:

Sir: In justice to one of the oldest and most enterprising, industrious and accomplished electricians of this country, I ask that you publish the following:

It appears from the article on page 272 of your issue of April 19, 1890, that Mr. Harry N. Marvin is credited with the invention of a reciprocating electric drilling apparatus, the principal features of which are comprised in a machine having motor coils connected in closed circuit with a special generator and alternately supplied with current, whereby the magnetic piston is forced from coil to coil and is magnetically cushioned, so that neither buffer springs nor other mechanism is required for arresting the momentum of the plunger at each stroke.

We are all entitled to criticise opinions as such, and we may also entertain opposite views and have our personal preferences where questions of taste or judgment are involved, but I have always understood that matters of fact were something about which differences of opinion could not exist.

The record of patents constitutes the great reservoir of scientific information, because whatever appears therein has been more or less carefully criticised, and the patenting of an invention gives it a certain legal standing.

On the ninth day of April, 1889, patent No. 401,231 was granted to Charles J. Van Depoele for precisely what is described in the aforesaid article, and investigation shows that patent to be the very first in this or any other country in which a reciprocating engine having motor coils in closed circuit with a generator supplying current to them alternately, is shown or described. It is amazing that a circumstance having such an important bearing upon the subject should have been ignored.

Mr. Marvin has unquestionably secured several patents, but it is only necessary to compare their dates and subject matter with the one above referred to.

I also invite your attention to patent No. 337,897, May 16, 1886, granted to Mr. Van Depoele, which, if language means anything, covers the very desirable iron envelope on such a device, and with claims the terms of which cannot easily be mistaken. Probably that article was prepared by some enthusiastic friend of Mr. Marvin, and without the slightest idea that there was anything in the record. As Mr. Van Depoele has been at work on this subject for years and has already obtained thirteen patents thereon, beginning with 1884, it does look as if Mr. Marvin was competing with Mr. Van Depoele instead of being himself a pioneer.

Frankland Jannus.

Washington, D. C., April 25, 1890.

The Electrical and Magnetic Disturbances at the Paris Observatory.

The efforts of the director of the Paris Observatory to modify the direction of the proposed extension of the Sceaux line have, says *La Lumière Electrique*, made public some very curious phenomena. The observatory is situated between two busy suburban lines, namely, the Chemin de Ceinture, which is only 60 metres away, and the Sceaux Railway, which is 80 metres distant. The passage of the Ceinture trains causes the bifilar magnetometer needles to oscillate so violently and distinctly that M. Descrois, of the observatory staff, is in a position to supply the railway company with a sheet checking the time of their trains. The curve of the declination needle, curiously enough, exhibits no traces of disturbance. The bifilar needle is kept by torsion at right angles to the magnetic meridian, and therefore parallel to the motion of the Ceinture trains; and M. Descrois is inclined to think that the observed disturbance is due to the fact that the wheels and axles become strongly magnetized, owing to their movement in the magnetic meridian. The Sceaux trains have no effect on the magnetometer needles, but give rise, on the other hand, to marked disturbance of the registering electrometers. The station on this line is at a distance of about 100 meters from the Observatory, and whenever the driver lets off steam the electrometer partially discharges, and then immediately afterward rises again to its normal potential. This singular phenomenon takes place no matter what the potential of the atmosphere may happen to be.

Life of Incandescent Lamps.

In response to numerous inquiries from correspondents we present herewith some details of the remarkable office building plant referred to in our columns recently. The annexed tables show in convenient form the amount of coal consumed per month, the lamp hours produced, mean life of lamps (deduced from breakage during the month), and the hours of lighting per pound of coal consumed. The record extends over the past two years and certainly gives a very encouraging account of the economy of electric lighting, at least in cases where the plant is of a reasonably large size. The life of the lamps shown is a trifle erratic, and the hours of life should not be taken too literally, but the figures are enough to show that the breakage, with lamps of modern construction and careful running, can be reduced to a very low figure. The lamps are said to have been running at their normal voltage. They certainly were not run below voltage by an amount sufficient to cause complaint on the part of users. The statements as to coal consumption have been carefully verified.

In response to numerous letters inquiring the make of lamps with which these results were obtained, we are enabled to disclose the fact that three different makes were in use, the Sawyer-Man, Perkins and United States. We have no record of their relative performances. The figures given are enough to show that electric lighting is distinctly economical in large buildings, and it is to be hoped that other isolated plants of like character will make similar reports, for they cannot but be of great value to the electrical fraternity at large, and will tend to establish a point often called in question, that is, the actual economy of lighting by incandescence.

1888.	Coal, in long tons and lbs. Tons.	Lbs.	Lamp hours.	Life of lamp.	Hrs. per lb. coal.
January	116	233	690,142	1,755	2 65
February	108	2,040	676,892	2,995	2.77
March	112	1,960	707,305	3,143	2.79
April	105	626	630,895	3,846	2.67
May	108	1,753	661 992	3,687	2.71
June	102	1,382	63 ,928	3,348	2.75
July	104	208	629,516	4,225	2.60
August	104	903	661,895	3,521	2.87
September	107	1,354	679,980	3,757	2.82
October	119	2,090	767,625	3,474	2.85
November	119	823	765.060	3,732	2.85
December	126	1,498	848,850	3,706	2.99
	1,336	1,435	8,353,080	3,250	2.78
1889.					
January	124	1,340	836,610	3,443	2.98
February	112	1,006	705,150	4,463	2.79
March	124	1,203	783,270	4,223	2.80
April	115	893	738,870	4,992	2.85
May	117	50	769,855	5.098	2.93
June	104	1,749	699,370	4,264	2.97
July	97	826	654,460	5,408	3.06
August	112	1,135	687,740	4,911	2.72
September	112	1,293	648,790	3.525	2.57
October	115	26	716,745	4,479	2.67
November	131	....	793,110	5,629	2.70
December	138	1,955	797,456	4,636	2.62
	1,406	276	8,831,435	4,464	2.83

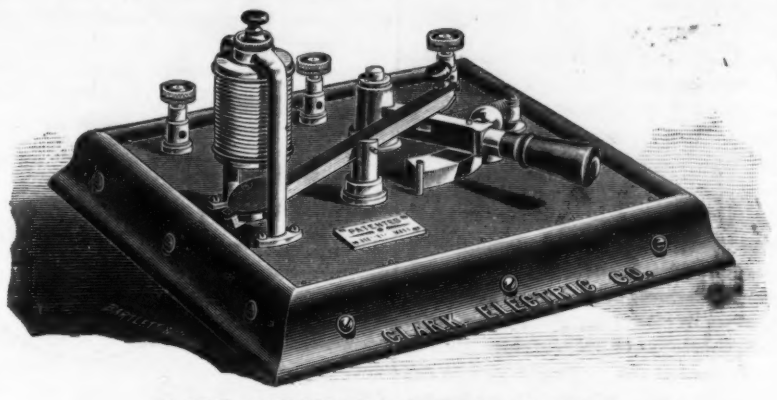
A Device for Lessening the Danger from Broken Wires.

The accompanying illustration represents one form of the new automatic safety device, recently placed upon the market by the Clark Electric Company of this city, and which has already been mentioned in these columns. It is well known that in case a live electric light wire breaks, the dynamo, still remaining in action, maintains an E. M. F. at the ends of the broken line, which, with some forms of apparatus, may be even greater than the normal working E. M. F. of the machine. If such broken ends should now come in contact with another conductor, thus closing the circuit, the result is an enormous rush of current, which, in some cases, has been sufficient to wreck the dynamo; or if, in falling, the broken lines come in contact with telephone or telegraph wires, the result is usually the destruction of the instruments attached to such wires, with the possibility of starting a serious fire. If, on the other hand, the ends of the broken wires do not come in contact with other conductors, but hang dangling in the streets, they offer the possibility of dangerous or even fatal shocks to any persons or animals coming in contact with them, as is shown by the numerous accidents of the kind on record.

These facts have long been considered as necessary evils by electric companies, but as evils which it would be very desirable to overcome if possible. This state of affairs has been particularly aggravating in New York city, where a few accidents, coupled with the absurdly alarming statements of the daily press, have brought about a state of mind in which the average citizen sees certain death in every dangling wire he comes across.

The object of the Clark Electric Company's safety devices is to prevent such accidents by putting the dynamo out of action the instant the wire parts, thus avoiding all danger of damage to the machine, as well as of accidents from fire or shock. These devices are constructed in various forms, according as they are to be used for series or shunt wound arc light dynamos or for alternating current machines.

The illustration represents the device for series wound arc machines, and it will be noted that the mechanical construction is of a simple form. The small electric magnet shown is located in the main circuit; and as long as the current flows, its armature lever is firmly held up, locking the switch in position. Should the line break or be cut by firemen or others, the current ceases instantly, and the armature of the electro magnet falls, releasing the switch, which flies back under the influence of its spring. The result of this movement of the switch is to close a short circuit across the field coils of the dynamo, thus depriving them of all current, and of course rendering the dynamo powerless.



CLARK AUTOMATIC SAFETY CUT-OFF.

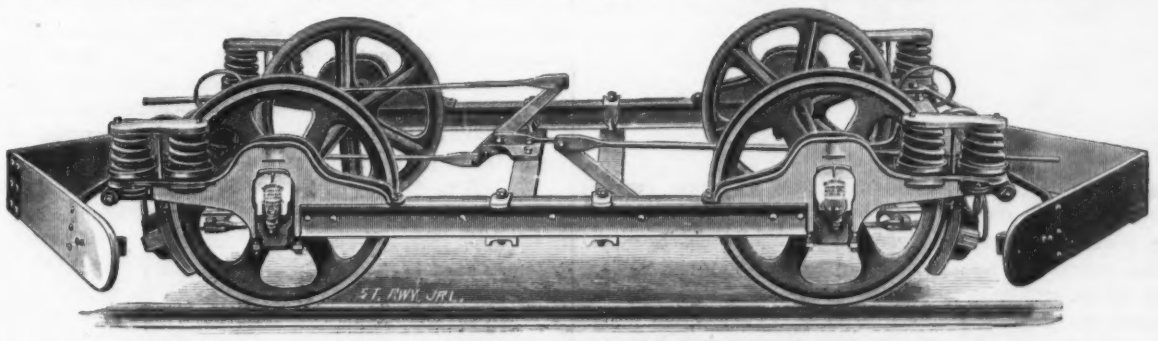
The hard rubber knob shown at the top of the magnet is attached to a rod reaching through the magnet core, and is used as a convenient means of throwing the dynamo out of action at any time; it being only necessary to force the armature away from the magnet. by pressing down the knob, to put the machine quickly out of action without any strains or shocks.

Another valuable feature of this device is that it works automatically every time the dynamo is stopped or put out of action, and it must be reset by hand, as the last thing to be done when starting the machine on its load. This, in a measure, insures its action when called upon, for should it get damaged or out of order the attention of the person in charge is called to it, as he must operate it every night in starting up.

The safety devices for shunt wound dynamos, and for alternators, vary somewhat from the foregoing description in their electrical details, but the above will show the general plan on which all are constructed; the object in all varieties of the device being to put the machine out of action instantly upon the breaking of the line, and to accomplish this with absolute certainty and without endangering the machine in any way.

A New Truck for Electric Cars.

An important point in this truck is the extended spring base, which enables it to carry a long car steadily on a six-foot wheel base, and makes an easy riding car without the excessive longitudinal rocking common to many six-foot wheel base cars, because, the springs being all located outside the wheels, there is no central point or pivot on which the car can rock; and it is therefore carried as it would be on an ordinary car gear with the wheels spread to nine feet. The attachment of the truck to the car being elastic in every direction, the load is carried with less strain on the car and roadbed, and there is less noise conducted from the wheels to the car. It is simple and strong in construction, the side of the truck being composed of but four pieces, and it is therefore durable and little liable to get out of repair. An axle and wheels can be moved by taking off four nuts; and by taking off eight nuts the car and truck frame can be lifted bodily from the axles and wheels. The journal boxes will run a year with one oiling, and are not only dust-proof but are water-proof. Muddy water is worse than dust, as it brings in grit and forces the oil out. These trucks and car gears are constructed almost entirely of wrought and malleable iron, and are warranted to be of the best material and workmanship. They are manufactured by the McGuire Manufacturing Company, of Chicago.



McGUIRE IMPROVED CAR TRUCK.

Historical Note on Thermal Batteries.*

BY HENRI BECQUEREL.

In the *Comptes Rendus* of the session of Feb. 17 last, Mr. Lucien Poincaré presented an interesting note upon thermal batteries and the thermo-electric forces at the surface of contact between a metal and a melted salt.

This note opened as follows: "Voltaic elements can be formed by plunging two different metals in a melted salt brought to a temperature high enough for it to become a conductor. Up to the present no one has investigated the systems thus formed."

The systems in question, on the contrary, have long been put forth as possible sources of electricity; but as they appear, from this quotation, to be little known, I desire in a few words to recall them.

Electrical currents obtained by taking a melted salt as an electrolyte were investigated by my grandfather, A. C. Becquerel, over thirty-five years ago. The setting free of the electricity accompanied either combustion of the carbon, or oxidation of different metals at the expenes of the electrolyte.

One of the arrangements consisted of melting potassium nitrate in a platinum vessel and plunging therein a rod of carbon the point of which was brought to a state of incandescence. By another method, called a pyro-electric couple, two different metals, a bar of iron and another of copper, were plunged into melted silicate, *e. g.*, into a fused mixture of glass and carbonate of soda. At the ends of the two bars was obtained an electric current four times weaker than the current from a Bunsen battery. There was, therefore, an electromotive force of about one-half volt.

With these couples could be produced various sorts of electrolysis; the similarity to hydro-electric batteries was complete, and the author believed that the pyro-electric couples would serve to utilize furnace-heat otherwise wasted.

In 1877 Jablochkoff again proposed the consumption of carbon in nitrates as a source of electricity.

In 1882 Brard published two notes on the subject, and constructed batteries in the form of bricks which, when placed in a fire, gave forth, while being consumed, a continuous current of electricity. This essay constitutes one of the most interesting efforts in the application of pyro-electric currents.

Finally, and quite recently, Messrs. Fabringi and Farkas in 1888 presented to the Academy some modifications of the system proposed by Jablochkoff, intended to render the current more constant.

It is thus evident that this question has frequently attracted the attention of scholars and inventors. The efforts to obtain a practical application have mainly had in view the combustion of the carbon, whereas the important essay of Mr. Poincaré, being entirely independent of previous work, applies itself directly to pyro-electric couples. It seems that these phenomena, according to the ideas of their discoverer, can become of important service in utilizing the heat now wasted in certain industries.

The furnace heat, in fact, is used only to keep the electrolyte in a liquid state; it is not transformed into electricity, so that a pyro-electrical apparatus placed in a furnace used for other purposes will not cause any additional consumption of combustibles. The economic production of electricity under these circumstances would depend simply upon the cost of the metals, salts, etc., from the chemical reaction of which is derived the current obtained

Comptes Rendus, t. CX., p. 444.

New York Electrical Society.

The New York Electrical Society had a most interesting gathering at the Lenox Lyceum on the 25th. The society invited the members of the Electric Club and the American Institute of Electrical Engineers to meet its members, and about 200 electricians and their friends were present.

On Current Distribution in Networks of Electrical Conductors.*

BY J. HERZOG AND L. STARK, BUDA-PESTH.

The distribution of electrical currents in any network of conductors can always be found by employing Kirchhoff's laws, provided that the configuration of the network and the resistances of the single parts of the conduits are given. If n be the number of unknown currents, we can always set up n non-simultaneous equations and thus find n expressions, with but one value each, for the unknown currents. The evaluation of these equations, however, requires, even in simple cases and by aid of the determinant-calculus, much time and trouble.

In the practice of electric illumination, nearly all networks show the characteristic features represented in Fig. 1. These features are :

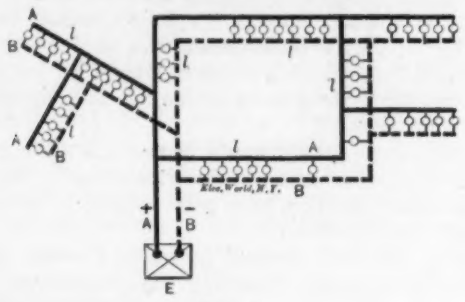


Fig. 1.

1. That all the current consuming devices l l are connected in parallel between two parallel networks A and B, and

2. That the mean fall of potential in the networks A B amounts to only a few per cent. of the useful fall of potential across the devices—that is, from the one network, A, to the other, B, through l l.

In the following discussion the principles of an approximate solution of the problems in such networks will be explained and illustrated by examples. Of these principles some have been in public use, others have been used half unconsciously in some special cases; others still are not yet known, so far as we are aware. Undoubtedly, every practical man will welcome a summary of these principles, even if it be not systematic from the standpoint of pure science. The more will this be the case as the calculations can be made without any severe task to memory or any stock of formulæ.

A relatively simple solution can be obtained for the problem.

1. To find the distribution of current and the losses in the conductors of a network of given configuration.

2. To predict the influence, upon the total current distribution, of any change of the cross-sectional area of one or several conductors and of any variations in the currents consumed ; and

3. To calculate the sectional areas of some or all conductors, in simple cases, certain losses of potential being assumed.

The simplest case is that shown by Fig. 2. A and B represent the terminals of a dynamo, an alternate current transformer, or the like; AO is the positive main, OB the negative or return conductor. The resistances of the devices connected between them, as incandescent lamps, arc lamps, etc., may be denoted by a_0, a_1, a_2, ..., the resistances of the parts of the mains between the points $01+0'1'$, $12+1'2'$, $23+2'3'$, $3A+3'B$, being marked by r_0, r_1, r_2, r_3, respectively, the resistance.

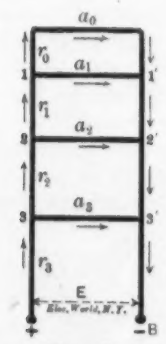


Fig. 2.

r_0 standing for the resistance of $01+0'1'$,
r_1 " " " $12+1'2'$,
r_2 " " " $23+2'3'$,
r_3 " " " $3A+3'B$.

The first problem is to find an expression for the total current the source AB has to supply; this source being, ordinarily, of nearly constant potential difference E between the terminals. A calculation of the total resistance of the network is sufficient, the total current intensity being, then,

$$I = \frac{E}{R}.$$

To find R we write down successively the resistances between the different points of derivation $11' \ldots AB$.

The resistance behind $11'$ is $= a_0 + r_0$. The device a being connected in parallel to this resistance, the resulting resistance

$$\text{at } 11' \text{ is} = \frac{1}{\frac{1}{a_1} + \frac{1}{a_0 + r_0}};$$

$$\text{at } 22' \text{ is} = \frac{1}{\frac{1}{a_2} + \frac{1}{r_1 + \frac{1}{\frac{1}{a_1} + \frac{1}{a_0 + r_0}}}}$$

and so forth. At last at AB we obtain the value of

$$R = \frac{1}{\left(\frac{1}{a_3}\right) + \frac{1}{r_3 + \frac{1}{\left(\frac{1}{a_2}\right) + \frac{1}{r_2 + \frac{1}{\left(\frac{1}{a_1}\right) + \frac{1}{r_1 + \frac{1}{\left(\frac{1}{a_0}\right) + \frac{1}{r_0}}}}}}}$$

As is well known, this expression may be independently represented as the quotient of two determinants which would likewise have been obtained by the employment of Kirchhoff's laws. This most simple case shows distinctly how difficult and time wasting the exact determination of the total current intensity turns out. The formulæ for the currents in a_0, a_1, a_2, ... r_0, r_1, r_2, ... and for the losses to the points of derivation, are no less complicated, and, in trying to calculate in this exact manner the cross-sectional areas of the mains AO and BO under the assumption of certain losses of potential, complications not to be overlooked are met with.

In practice, of course, nobody will try to work in the above manner. For practical cases, an approximate method is in use that easily renders sufficiently exact results. If, in spite of this, the exact method has been touched upon, it was merely to remind the reader that the usual method of calculation only gives approximately correct values—a fact easily forgotten in the hurry of business practice.

The train of thoughts leading to this approximate method is as follows :

The loss of potential between the points of first and last derivation may only amount to a few per cent. of the useful tension. This is the condition necessary to keep the latter nearly uniform throughout the network with a constant current supply, and for admitting a slight variation only of the useful tension, with widely varying current supply. Then each device may be assumed always to take the same amount of current in inverse proportion to its internal resistance, no matter whether it be nearest to or furthest from the source and no matter what happens with the other devices. The currents consumed by the devices may therefore be introduced from the very beginning, instead of the various resistances.

In the following only one of the mains is drawn and dealt with, the other one being ordinarily symmetrical with it. Should this not be the case, the return conductor is to be dealt with in a special computation.

Fig. 3 may be regarded as a simplification of Fig. 2. In

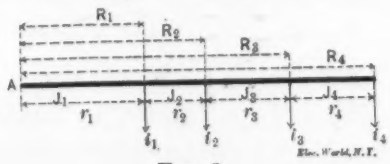


Fig. 3.

this figure i_1, i_2, i_3, i_4 ... denote consumed currents—I_1, I_2, I_3, I_4....current sums in the respective parts of the main—r_1, r_2, r_3, r^1 ... the resistances of these parts--R_1, R_2, R_3, R_4...the sums of these resistances reckoned from A.

The total loss of tension in the mains is composed of the losses in the parts of the mains; this may be written:

$$V = I_1 r_1 + I_2 r_2 + I_3 r_3 + I_4 r_4 + \ldots = \Sigma (I.r$$

Substituting their values for the current sums, viz.:

$$\begin{aligned} I_1 &= i_1 + i_2 + i_3 + i_4 + \ldots \\ I_2 &= \quad i_2 + i_3 + i_4 + \ldots \\ I_3 &= \quad\quad i_3 + i_4 + \ldots \\ I_4 &= \quad\quad\quad i_4 + \ldots \end{aligned}$$

we obtain

$$V = i_1 R_1 + i_2 R_2 + i_3 R_3 + i_4 R_4 + \ldots = \Sigma (i R);$$

thus

$$\Sigma (I r) = \Sigma (i R).$$

To get the total loss of tension we have thus to add all the products of each device's current into the resistance between this device and the source. Calling the product of a partial current into a resistance-sum the moment of the current, we may abridge by saying: The total loss of potential in a network, as shown in Fig. 2 or 3, is equal to the sum of moments of the currents.

Writing

$$V = \Sigma (I.r) = \Sigma (i R) = (\Sigma i).\zeta = I.\zeta,$$

we see that the total loss of potential may also be found by multiplying the total current with an ideal resistance

$$\zeta = \frac{\Sigma (i R)}{\Sigma i}$$

If the sectional area of the main be the same throughout its length, the resistances are in proportion to the lengths of conductors. The ideal resistance, then, corresponds to an ideal distance which may be called the distance of the centre of gravity of the current-consuming devices.

An explicit graphical treatment upon the calculation of conduits from this point of view may be found in a paper of Hochenegg, *Vienna Zeitschrift f. Elektrotechnik*, 1887.

The case represented in Fig. 3 may be complicated by branching mains of the second order, which may be split up as the main in Fig. 3; or, further still, this enlargement of the network does not require any further explanations, each branch main being dealt with as a consuming device with regard to the main. Furthermore, each branch main is calculated like the main in Fig. 2, the points A B being looked at as points of derivation.

Networks of conductors, such as have been dealt with so far, may be called *open* networks. The simplest case of a

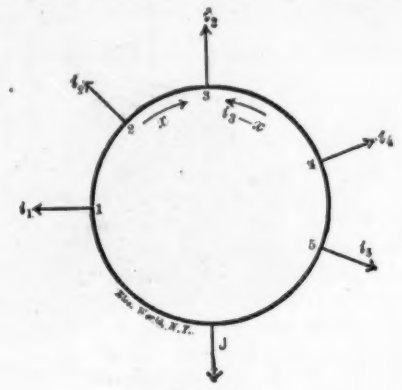


Fig. 4.

closed network is represented by Fig. 4. An annular conductor is fed at one point, A, currents being taken off at different points, 1, 2, 3, ... At first only the total current can be found by adding the branch currents, i_1, i_2, i_3, ... At point A the total current divides into two parts, which generally meet again at some definite point of derivation. Cutting the annular conductor at this point will exert no disturbing effect upon the current distribution. For, if this point has been determined in some way, and found, say, at 3, current i_3 may be imagined as composed of two partial currents, the one, x, coming from the left, the other $(i_3 - x)$ from the right side. In this way the closed ring-conduit is split up into two open circuits for which the calculations can be made as above.

We can now deduce a simple method for determining the point through which the cut should be made.

To simplify ideas, imagine the ring-conduits cut at A

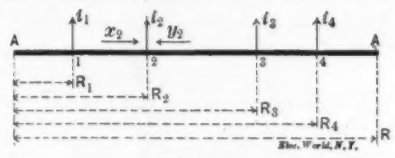


Fig. 5.

and stretched out into a straight line as shown in Fig. 5, where the notation is analogous to that previously employed. Any branch current, then, is equal to the sum of the currents contained by the neighbor conductor parts; for instance,

$$i_2 = x_2 + y_2 \qquad (1)$$

If 2 be the point where the currents from the right and left side meet, x and y have the same, say the positive, direction with regard to 2, as indicated by the arrows. If 2 be not the required point at which to place the cut, one of these partial currents will arrive at this point, whilst the other will depart from it. In other words, one of them will turn out positive and the other negative in the following reckoning. Thus, the signs of these currents will prove whether the point of the cut be well chosen or not. A determinate value of potential will exist at 2; but the loss from the left side A to 2 will be equal to that from the right side A to 2; therefore:

$$x_2 R_2 + i_1 R_1 = y_2.(R - R_2) + i_3.(R - R_3) + i_4.(R - R_4) + . \qquad (2)$$

which equation will immediately be recognized as Kirchhoff's second law. From equations (1) and (2) result:

$$\begin{cases} x_2 = i_3 + i_4 - \dfrac{i_1 R_1 + i_2 R_2 + i_3 R_3 + i_4 R_4}{R} \\ \\ y_2 = -\left(i_3 + i_4 - \dfrac{i_1 R_1 + i_2 R_2 + i_3 R_3 + i_4 R_4}{R}\right) \end{cases}$$

Denoting the sum of products,

$$\sum_1^4 (i_n R_n) = M,$$

the following expressions for the currents x_n and y_n are obtained:

$$x_1 = i_1 + i_2 + i_3 + i_4 - \frac{M}{R} \qquad y_1 = -\left(i_2 + i_3 + i_4 - \frac{M}{R}\right)$$

$$x_2 = \quad i_2 + i_3 + i_4 - \frac{M}{R} \qquad y_2 = -\left(i_3 + i_4 - \frac{M}{R}\right)$$

$$x_3 = \quad\quad i_3 + i_4 - \frac{M}{R} \qquad y_3 = -\left(i_4 - \frac{M}{R}\right)$$

$$x_4 = \quad\quad\quad i_4 - \frac{M}{R} \qquad y_4 = -\left(-\frac{M}{R}\right)$$

These equations show that

$$-y_1 = x_2,$$
$$-y_2 = x_3,$$
$$-y_3 = x_4,$$

* Communicated by the authors for simultaneous publication in the *Elektrotechnische Zeitschrift* and The Electrical World.

which is obvious as the currents in one and the same part of the main, reckoned for its commencement and end, can only differ by their signs. Besides, it may be noticed that every two consecutive values of x or y differ only by the value of current i, branched off between the respective parts of the main:

$$x_n - x_{n+1} = i_n,$$
$$y_n - y_{n+1} = i_{n+1};$$

Substituting in the above equations the numerical values of i_n, M and R, and calculating x_n and y_n, we will find two corresponding values of these currents, which will both be positive. The point corresponding to these currents will show the exact place for the cut. If, for example, 2 be the derivation, where the division takes place, x_2 and y_2 have to be positive, else

$$i_2 + i_3 + i_4 > \frac{M}{R} > i_3 + i_4$$

For all other points one of the currents would be negative. A singular case exists, if for two neighboring points, say 2 and 3, the current in the whole distance between them becomes zero:

$$y_2 = x_3 = o$$

This shows that the part 2,3 could thus be omitted, and that the currents i_1, i_2 may be considered as arriving from the left and i_3, i_4 from the right side.

Now, it will be shown that it is not necessary to calculate all the x's and y's to find the cutting point of a closed circuit, but that it suffices to make the calculation for any x and the corresponding y, at a point chosen anywhere. The resulting values allow a conclusion upon the position of the real cutting point without any further trials, even if the first point chosen had been wrong.

The currents x and y are in intensity as well as in direction identical with those actually flowing, and two consecutive values of x or y only differ by the value of the current taken off between them, to which fact we referred in the previous discussion of the expressions for x_n and y_n. If, therefore, for any chosen point n we obtain, say, a positive value of x_n and a negative value of y_n, we have to proceed in the direction of y_n to the next point of derivation $(n+1)$, whose current consumption i_{n+1} will, in general, be either greater or less than y_n. In the first case, this point will be the right point of cutting, as from the other side another current, $= + y_{n+1}$, must flow towards it which must have the same sign with regard to the point $(n+1)$ as the current $-y_n = + x_{n+1}$. In the second case, we subtract the derived current i_{n+1} from x_{n+1} and proceed with the negative value of y_{n+1} till we reach the right point to place the cut.

If $y_n = x_{n+1}$, then $y_{n+1} = o$ and therefore also $x_{n+1} = o$. This is the singular case before mentioned.

A numerical example will serve to explain this method.

A closed main circuit is laid in the basement of a building (Fig. 6), of which three conduits, 1, 2 and 3, with 130, 110 and 150 ampère, respectively, lead to the different floors. At A the current of some dynamo or transformer-station enters; from A to 1 a round copper bar 20 millimetres in diameter is employed, the rest of the main circuit being formed of a bar 18 millimetres in diameter. The specific conductivity of copper is taken as 60.

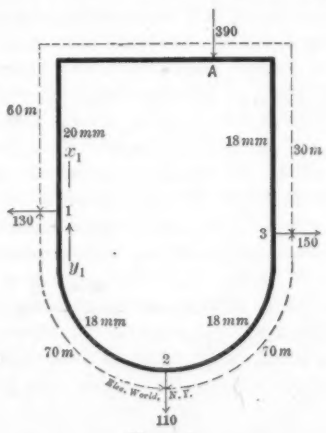


FIG. 6.

If we imagine the cut to be at any point, as at 1, we obtain the following equations for this point:

$$x_1 + y_1 = 130 \qquad (1a)$$

$$x_1 \cdot \frac{60_m}{60. \frac{20^2\pi}{4}} = y_1 \cdot \frac{70_m + 70_m + 30_m}{60. \frac{18^2\pi}{4}}$$

$$+ 110_A \frac{70_m + 30_m}{60. \frac{18^2\pi}{4}} + 150_A \frac{30}{60. \frac{18^2\pi}{4}} \qquad (2a)$$

whence $\begin{cases} x_1 = 172 \text{ amp.} \\ y_1 = -42 \quad \text{“} \end{cases}$

Hereby we have obtained the right values of the currents, together with their directions. The part A-1 thus contains a current of 172 ampères, the derivation at 1 taking 130 ampères; in the part 1-2 a current of 42 ampères continues to flow in the direction towards 2, where 110 ampères are consumed by addition of 68 ampères from 1. Between 2 and 3 a current of 68 ampères must, therefore, be flowing towards 2, while the distance A-3 is passed by a current of $68 + 150 = 218$ ampères in the direction towards 3.

We see that 2 is the point to open the closed circuit by attributing 42 ampères to the left-side and 68 ampères to the right-side conduit. The loss of potential to this point in the main conduit amounts to 0.74 volts, as calculation shows, and if the return conduit is symmetrical with it, the loss in both is equal to 1.48 volts.

In order to show that the same result would be obtained by choosing any other point of derivation, the equations (1) and (2) may be set up for the point 3, also. Here

$$x_3 + y_3 = 150 \qquad (1b)$$

$$y_3 \cdot \frac{30}{60. \frac{18^2\pi}{4}} = x_3 \cdot \left(\frac{70 + 70}{60. \frac{18^2\pi}{4}} + \frac{60}{60. \frac{20^2\pi}{4}} \right) +$$

$$110 \left(\frac{70}{60. \frac{18^2\pi}{4}} + \frac{60}{60. \frac{20^2\pi}{4}} \right) + 130. \frac{60}{60. \frac{20^2\pi}{4}} \qquad (2b)$$

whence $\begin{cases} x_3 = 68 \text{ ampères.} \\ y_3 = 218 \quad \text{“} \end{cases}$

in exact conformity with the former values. Proceeding with 68 ampères from 3 toward 2, we notice that 42 ampères must arrive at 2 from the other side, 2 being the right point of cutting, as was also found with x_1 and y_1.

Besides, it may be mentioned that by employing a copper bar of 18.6 millimetres diameter throughout the same loss of potential would have been attained with less expense of copper.

Many networks in city lighting lead to the case just dealt with. If, for example, in Fig. 7, O is the central station and I and II are the points where O I and O II join, and if, besides, the tension at the points I and II is kept up to the constant value V, independent from the current consumed, the reckoning with regard to the distributing main II leads to the solution above treated.

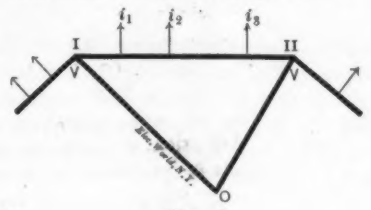
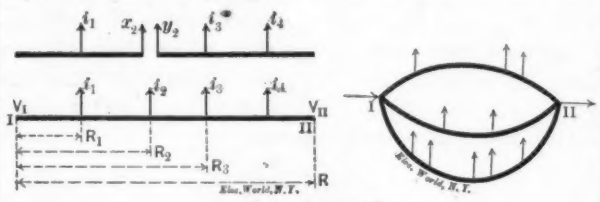


FIG. 7.

If, however, the tension V_I at I differs from that V_{II} at



FIGS. 8 AND 9.

point II (Fig. 8), the computation is somewhat altered. If, namely, the tension at 2, reckoned from I is equal to that reckoned from II, the loss v_I from I to 2 may not be equal to the loss v_{II} from II to 2, but

$$V_I - v_I = V_{II} - v_{II}$$

or $V_I - 2\,(x_2\,R_2 + i_1\,R_1) = V_{II} - 2\,[y\,(R_1 - R) + i_3\,(R - R_3) + i_4\,(R - R_4)]$;

furthermore $x_2 + y_2 = i_2$, as before, whence

$$\begin{cases} x_2 = \dfrac{V_I - V_2}{2\,R} + i_2 + i_3 + i_4 - \dfrac{M}{R} \\ y_2 = i_2 - x_2. \end{cases}$$

Thus the computation made for the simple ring circuit is valid here, and the method is essentially the same as before. At any point of the derivation we imagine the departing current i subdivided; write down the two equations for tension and current, and calculate the current distribution for the chosen point of cutting, which will be identical with the actual distribution, and will at once lead to the true point to place the cut for reckoning the total loss of tension.

If other current consumers are branched off the mains to the left of I or to the right of II, it may happen with larger differences between V_I and V_{II}, that the true point of cutting does not lie upon the distance I II, but falls either upon the points I or II; or—if more feeders than AI and AII should exist—lies somewhere between the points of junction of these feeders.

Next we will take into consideration the case where several conductors meet at two knots or points of junction I and II (Fig. 9). The current may enter at I and depart at the different branches as well as at the point II.

The calculation of the current distribution may again be shown by a numerical example represented by Fig. 10. It will be noticed that in one of the branches, 150 mm² in section, no current is taken, the branch thus serving as an auxiliary conductor. In this case it is best to imagine the junction dissolved at II, for it is easier to set up the equations for this point than for the case where the highest and the lowest branches are cut.

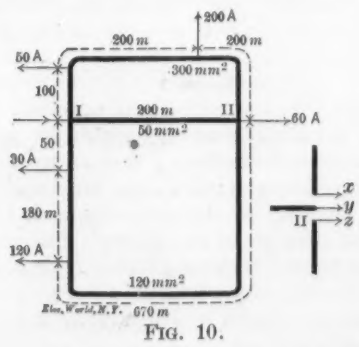


FIG. 10.

The equations are:

$$x + y + z = 60 \qquad (1)$$

$$x \cdot \frac{200 + 200 + 100}{300} + 200. \frac{200 + 100}{300} + 50. \frac{100}{300} = y. \frac{200}{50} \qquad (2)$$

$$z \cdot \frac{670 + 180 + 50}{120} + 120. \frac{180 + 50}{120} + 30. \frac{50}{120} = y. \frac{200}{50} \qquad (3)$$

Whence: $x = 5.7$ ampères.
$y = 56.5$ “
$z = -2.2$ “

We find that the auxiliary lead transfers 56.5 ampères to the knot II; that, furthermore, 2.2 ampères return by the lowest conductor. Hence a view of the correctly cut network is represented by Fig. 11.

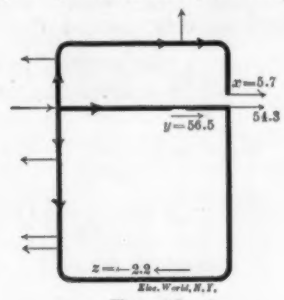


FIG. 11.

A question of much interest is what influence the size of the section of the auxiliary conductor exerts upon the current distribution. Denoting the sectional area of this lead by f, the following equations are obtained:

$$x + y + z = 60 \qquad (I)$$

$$1.67\,x + 216.6 = \frac{200\,y}{f} \qquad (II)$$

$$7.5\,z + 242.5 = \frac{200\,y}{f} \qquad (III)$$

whence, for the three unknowns, expressions of the following form result:

$$\begin{cases} x = \dfrac{M f + N . f^2 + O}{P f - Q f^2 + I} \\ y = \dfrac{A - B f}{C + D f} \\ z = \dfrac{G}{H + \dfrac{k}{f}} \end{cases}$$

From these equations we find for:

$f = 0$	$f = 50$ mm²	$f = \infty$
$x = 51.9$ amp.	5.7 amp.	—129 amp.
$y = 0$ “	56.5 “	221.2. “
$z = 8.1$ “	—2.2 “	—32.2 “

From these values it may be seen that by a diminution of f the current x becomes greater and y smaller, while z first decreases, then vanishes for a certain value of f ($= 110.5$ mm²) and afterward increases again. By increasing f above 50 mm² x first becomes smaller, than passes through zero, and afterward increases again to a maximum of — 129 ampères; at the same time y attains a maximum of + 221.2 ampères, and z amounts to — 32.2 ampères. A complete interruption of the auxiliary lead would, therefore, bring x to about 52 ampères and z to about 8 ampères, while with an infinite section of the auxiliary lead, x would amount to — 129 ampères and z to 32 ampères. In the first case two true-cutting point would exist, one in the upper conduit at 2 and one in the lower at 4. The physical meaning of $f = \infty$ is that points I and II are joined into one (Fig. 12). The network is thus reduced to two ring conduits.

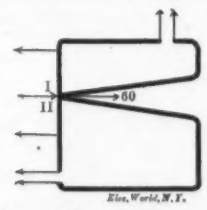
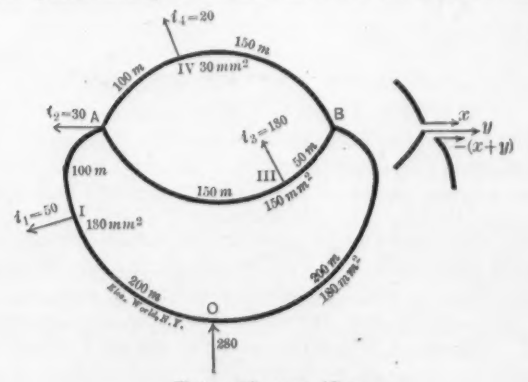


FIG. 12.

The question may be raised how the cut is to be imagined through a point of junction such as II in Fig. 13, where no current consumption takes place. This means only that the departing current = 0. The cut may therefore be placed in a manner similar to that in the former case, viz., we imagine the three conduits meeting at II separated as shown in Fig. 13*a*; call the currents in two of



FIGS. 13 AND 13 a.

them x and y, whence the third current must be equal to $-(x+y)$, as $x+y-(x+y)=0$.

For the two unknowns we set up two equations, one of which expresses that the loss of potential from I over i_4 to II is equal to that from I over i_3 to II, while the second signifies that the loss of potential over I and i_1 to III amounts to the same as that from A over the right-hand conductor to II.

$$x.\frac{150+100}{30}+i_4\frac{100}{30}=y.\frac{50+150}{150}+i_3\frac{150}{150} \quad (1)$$

$$-(x+y).\frac{200}{180}=y.\left(\frac{50+150}{150}+\frac{100+200}{180}\right)+$$

$$i_3.\left(\frac{150}{150}+\frac{100+200}{180}\right)+$$

$$(i_3+i_4+x)\frac{100+200}{180}+i_1.\frac{200}{180} \quad (2)$$

Whence:

$$\begin{cases} x=\dfrac{30\,i_3-80\,i_1-108\,i_2-848\,i_4}{2038} \\ y=\dfrac{-500\,i_1-675\,i_2-1341\,i_3-205\,i_4}{2038} \end{cases}$$

Substituting the numerical values for i_1, i_2, i_3, i_4, we obtain

$$x=-\ 9.2 \text{ ampères.}$$
$$y=-142.5\ \text{“}$$

To reach the real points of cutting we have to proceed

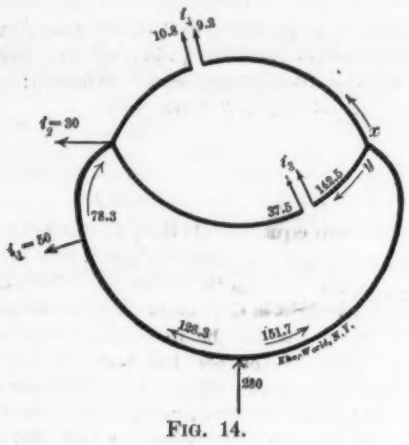


Fig. 14.

from x and y towards the point of junction III, and find them at i_3 and i_4 (Fig. 14).

It may be noticed that of the expressions for x and y the denominators are the same, the numerator of x being composed of positive and negative items, while that of y contains only negative items. We may reason therefrom that x reaches its positive maximum, if the negative parts become $=o$, and its negative maximum if the positive parts become $=o$.

In the first case

$$i_1=o;$$
$$i_2=o;\ x_{\max}=2{\cdot}3 \text{ amp.};$$
$$i_3=o;$$

in the second, however,

$$i_3=o;\ x_{\max}=-11{\cdot}9 \text{ amp.}$$

The current y possesses a negative maximum only equal to that calculated $=-142.5$ amp.

To find the highest current intensity possible in the lead AII, we have to find the maximum of $(x+y)$, which is

$$x+y=\frac{1}{2038}\ (-848\,i_4-108\,i_2-80\,i_1-500\,i_1-675\,i_2-$$
$$205\,i_4-(1341-30)\,i_3=-151.7$$

the same current which circulates when all the points of current consumption are fully loaded.

The current in the lead $Ii_4=i_4+x$ attains its maximum value when x has its highest positive value $=+2.3$. Then the maximum for the current in Ii_4 equals $20+2.3=22.3$ amp.

The current in Ii_3 is

$$i_3-y=i_3-\frac{1}{2038}.(500\,i_1+675\,i_2+1341\,i_3+205\,i_4$$

Therefore we find for the negative maximum $i_3=o$ and $i_3-y=-24.2$ amp., and for the positive

$$\left.\begin{matrix} i_1 \\ i_2 \\ i_4 \end{matrix}\right\}=o \qquad \text{and } i_3-y=+61.6 \text{ amp.}$$

The current Ai_1 is

$$i_1+i_2+i_3+i_4-x-y=\frac{1}{2038}.$$
$$(1458\,i_1+1255\,i_2+727\,i_3+985\,i_4).$$

The numerator contains only positive products, which implies that the current in question has only a positive maximum existing, when all the points of current consumption are fully loaded. Its value is equal to that already noted in Fig. 14 = 128.3 ampères.

Gathering all the results of these inquries for the maximum values of different currents, we see that the currents in the leads AI and AII have positive maxima with regard to the knots I and II as soon as all the current consumers are connected; with this current consumption y reaches its single negative maximum within the part Ii_1. Current x in IIi_4 reaches its positive maximum with regard to II if all the current consumers except i_3 are disconnected; at the same time the currents in Ii_4 and Ii_2 are upon their positive maxima. The latter current, as well as x have a negative maximum (with regard to i_4 as soon as $i_3=o$.

Before concluding we will, by aid of a network with five knots (Fig. 15) give some general remarks pertaining to the principles necessary in order to find the maximum currents circulating in the different leads in consequence of some groups of current consumers being disconnected. To examine these relations, it has been customary to have a reproduction made of and in proportion to the network

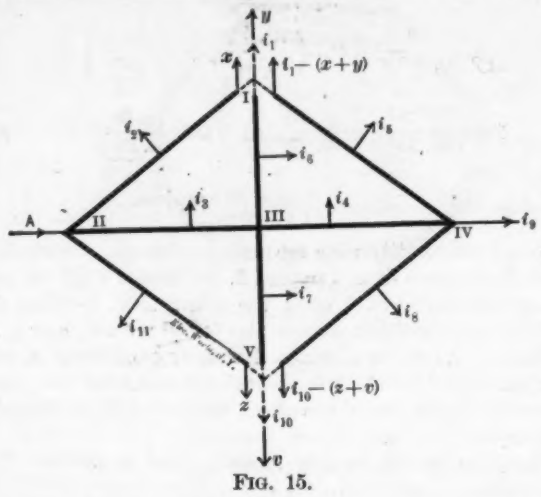


Fig. 15.

in question, and to study the influence of fluctuations in the current consumption experimentally in this model.

In Fig. 15 it will be most simple and explicable to cut the knots I and V. In this way four unknown quantities will result, for which four equations may be be set up by noticing that the tensional loss

on the way $I_2\ II$ equals that on the way $I_6\ III_2\ II$,
“ “ “ $I_2\ II$ “ “ “ “ $I_5\ IV_4\ III_2\ II$,
“ “ “ $V_{11}\ II$ “ “ “ “ $V_7\ III_2\ II$,
“ “ “ $V_{11}\ II$ “ “ “ “ $V_8\ IV_4\ III_2\ II$.

The form of these four equations is:

$$r_{11}\ x+r_{12}\ y+r_{13}\ z+r_{14}\ v=\Sigma\,[i_n\ f_1\ (r)]=\alpha_1,$$
$$r_{21}\ x+r_{22}\ y+r_{23}\ z+r_{24}\ v=\Sigma\,[i_n\ f_2\ (r)]=\alpha_2,$$
$$r_{31}\ x+r_{32}\ y+r_{33}\ z+r_{34}\ v=\Sigma\,[i_n\ f_3\ (r)]=\alpha_3,$$
$$r_{41}\ x+r_{42}\ y+r_{43}\ z+r_{44}\ v=\Sigma\,[i_n\ f_4\ (r)]=\alpha_4.$$

where $r_{11}, r_{12}, r_{13} \ldots r_{44}$ are only sums of given resistances of leads and $\Sigma\,[i\ f_m\ (r)]$ denote sums of products of variable currents i_n into algebraical functions $f_m\ (r)$ of invariable resistance of leads. As is well known, we can find from these equations:

$$x=\frac{\begin{matrix}\alpha_1 & r_{12} & r_{13} & r_{14}\\ \alpha_2 & r_{22} & r_{23} & r_{24}\\ \alpha_3 & r_{32} & r_{33} & r_{34}\\ \alpha_4 & r_{42} & r_{43} & r_{44}\end{matrix}}{N}$$

and y, z and v in the same way. N is a determinant common to all four unknowns and formed of their coefficients, therefore not depending upon the current consumers. The numerator, however, contains the sums of products which stand upon the right side of the equations and solely depend upon the current consumption. Thus the maximum values of the currents x, y, z and v coincide with the maxima of the numerator determinant. We may thus write:

$$x=\frac{1}{N}\Sigma\,[i_n\,.\,F_1\ (r)]$$

$$y=\frac{1}{N}\Sigma\,[i_n\,.\,F_2\ (r)]$$

From these equations the influence of a variation of one or several currents i upon x, y, z and v may be reckoned. In general, however, only the maximum values of these currents are of interest. To find these in a simple manner, we arrange the $\Sigma\,[i_n\ F_m\ (r)]$ in two parts, of which one contains only the negative, the other only the positive items; according as we take either the positive or the negative part $=o$, we obtain the negative or positive maxima of the currents x, y, z, and v. The maximum currents in the other parts of the mains may be found by writing down the values of these currents, divided into a positive and negative part as shown, and taking one of these parts equal zero—or by using in the expressions for these currents directly the maximum values of x, y, etc.

The examples quoted and reckoned out in the above will certainly suffice to make intelligible the employment of this “*method of cutting*” for the calculation of current distribution in given networks. In a few sentences the method described above may be put down as follows:

1. Imagine the given network cut at any point of derivation, or junction, in such a way that it is divided solely into open nets, and that no part of any conductor be without connection with one of the feeding points.

2. Regard the currents flowing within the parts of conductors to or from the cutting points as unknown x, y, z. Set up the equations and solve them for these unknowns. The values obtained are the real ones, and, at the same time, give the direction of all unknown currents.

3. The real cutting points are found by proceeding in the direction of the currents calculated according to 2, so far as to reach points, in regard to which both the currents are positive.

4. After cutting the network at points thus found, calculate the numerical values of the loss of potential which is maximum at the said points.

5. To find out the influence of any change in the sectional area of any conductor upon the current distribution, we arrange the expression for x, y, with regard to the sections in question and then discuss them.

6. To determine the influence of changes in the current consumption upon the distribution of current, we arrange the expressions for x, y as well as those for the currents in the other parts of the mains with regard to the current consumed. To find the positive or negative maxima we take the negative or positive parts $=o$.

The Delany Speed Indicator.

Mr. Delany writes to The Electrical World to say that his speed indicator, as readjusted after the fast telegraphic tournament, will register thirty impulses per second for continuous service. This is far in excess of the amount stated as the speed in the last issue, and is high enough to register any sort of sending short of an automatic transmitter.

Concerning Induction Coils.

To the Editor of The Electrical World:

Sir: I should like to receive answers to the following questions:

1. Please give the dimensions of an induction coil that will be capable of producing fully a 4-inch spark, that is, the size of the primary wire, and how much; the size of the secondary, and how much.

2. What battery would be best to supply the necessary current, and how many cells should I use? If I increase the number of cells would it increase the length of the secondary spark?

3. What would be the electromotive force of the secondary current of such a coil?

4. If, after the coil is finished, I set it into an iron case, would that iron case increase the ampères or volts?

5. What is the size of wire used in ordinary street arc-lighting and the candle power of ordinary street light?

6. What is the size of wire used in ordinary incandescent lighting, and the size of wire that is tapped on to run into buildings; also the name of such wire to distinguish it from the mains?

7. Which is best for permanent magnetizing purposes, alternating or direct currents?

8. What is the size of wire in both secondary and primary of an ordinary converter?

9. Which is the more important for lighting and magnetizing purposes, quantity or intensity?

10. How many more turns are there of wire in primary than in secondary of a converter?

11. If both coils had the same number of turns of wire, of the same size, what would be the effect in the secondary?

12. Does the presence of iron in the converter increase the strength of the primary or secondary, or both?

Subscriber.

[1. It is well-nigh impossible to design a coil for a given length of spark, but the following dimensions will give a coil of about the power you require:

Core, a bundle of soft iron wire 1½ inches in diameter, 12 inches long. Wire should be about No. 18, and this core should be surrounded with a paper tube insulated with shellac varnish. On it wind the primary of three layers of No. 15 double cotton-wound wire, also shellacked. Outside of this, place an insulated tube of vulcanized fibre of hard rubber, about $\frac{1}{16}$ inch thick. Cover this with several layers of shellacked paper. Then wind on the secondary of white silk double-wound wire No. 33. Lay on about 30,000 feet, giving each layer a coat of shellac and interposing a sheet of thin, tough, shellacked paper between every two or three layers, form a condenser of 125 sheets of tinfoil 12 by 6 inches, separated by sheets of tough compact paper well soaked in shellac. The greatest care must be taken with the insulation throughout, or the coil is likely to break down while in use. Use a magnetic make and break of the ordinary kind, with platinum contacts.

2. Employ five large flat Grove cells or an equal number of gallon Bunsen cells. More cells would increase the length of the spark, but might strain the insulation.

3. About 100,000 volts.

4. Don't use an iron case. It would make the action of the coil a little sluggish.

5. For ordinary arc lighting wire Nos. 4 to 6 is in pretty general use.

6. For incandescent lighting, everything, from copper bars one-half inch and more in diameter, down to No. 16 wire, is employed. The size used for entering houses depends on the distance from the main, and the number of lights to be supplied. Consult some handbook on incandescent wiring for details.

7. The direct current. An alternating current, even if rectified, is not equivalent to the direct current for magnetizing purposes.

8. The size of wires used varies with the capacity of the converter. In one, of which we have a description, for transforming 1.5 ampères at 1,000 volts down to 40 volts, there were 300 turns of No. 19 wire in the primary and 12 turns in the secondary, each composed of 25 No. 8 wires, arranged in parallel.

9. For lighting, quantity of current. For magnetizing, ampère turns.

10. In general the ratio of number of turns equals the ratio of electromotive forces in primary and secondary nearly.

11. The voltage in the secondary circuit would be nearly the same as the voltage across terminals of the primary.

12. The iron simply increases the effective induction produced by the primary by making a better magnetic circuit.—Ed. E. W.]

An Improved Street Railway Pole.

The overhead system being at present most largely in use for electric street traction, any device calculated to lessen its acknowledged imperfections is of practical importance. One such seems to be the Milliken patent pole, for which Lemuel Wm. Serrell, of New York, is agent. This pole is formed of four sections of iron of the Phœnix shape, riveted together, with tie plates placed equi-distant, and with lacing inserted at the point of greatest strain. A taper is given in the direction of greatest strain (as shown in the cut of the pole for the side of the street), making a pole having the greatest possible strength for the weight of material used. It is very light, durable and cheap, and, being open, presents a very pleasing appearance, while the inside can be painted and indefinitely preserved from the action of the air.

The pole was recently tested at the Post & McCord Bridge Works in Brooklyn, and the pull at the top measured by a Fairbanks dynamometer. With a pull of 800 pounds the deflection was less than 4 inches, and took place in a regular curve, showing no irregular bending. A block and tackle was then attached to the upper end of the pole and eight men pulled on the rope. Unfortunately, the concrete was not quite dry and the pole moved bodily in the earth, the top being moved some 6 feet toward the building, breaking the concrete into lumps. When taken out of the ground the permanent set was so small that the pole was readily straightened.

The centre pole for use between the tracks has its longest diameter parallel with the rails; and when arranged with an ornamental top and lamps, produces a very artistic effect. The cross-arms can be made separate from the pole if so desired for shipment, and bolted on after it is set in the ground. A cast-iron bumper to keep wagon wheels from striking the pole is provided at the bottom. This is made in two halves, bolted together on the inside, and can be filled with concrete as shown in the cut.

A number of these poles are now being made for the Jersey City & Bergen Railway company, which recently closed a contract for the equipment of its lines with the Thomson-Houston company.

Field-Magnet Coils for Dynamos.*

BY GISBERT KAPP.

The determination of the winding of any field-magnet coil to produce a given exciting power with a given expenditure of energy is a very simple operation, requiring no other electrical knowledge than that of Ohm's law and the ability to use resistance tables. But even the most simple operation, if it has to be performed over and over again, becomes tedious, and as in the design of field coils we must to a certain extent proceed on the trial and error method, any comprehensive formula by which we can shorten the calculations will, in the long run, effect a considerable saving of time and labor. Such formulæ can easily be established, and are simple enough for daily use, as the author can testify from his own experience. In considering the kind of formulæ wanted, we may start from two distinct points of view; we may either make the total expenditure of energy the determinant factor, disregarding entirely the temperature to which the coil will be raised, or we may make the temperature the determinant factor, and take no account of the energy. The former method will be used in all cases where the total efficiency of the machine is the most important consideration, and the latter method where low cost and ability to pass a temperature test are paramount.

In either case it is assumed that the exciting power X of the coil expressed in ampère-turns has been found, or is given; that the thickness and width, or the diameter of the magnet core is given, and that the length of the former, upon which the coil is to be wound, has been settled as part of the general design of the machine. What we require to know is the depth of winding and weight of wire in the coil. It is convenient to be able to determine these quantities without having previously to ascertain the size of wire and insulation, number of layers, turns per layer and resistance. All these quantities must, of course, ultimately be determined, but for the preliminary calculation in connection with a design which may be considerably modified before its final adoption it is not necessary to know them. All we care to know is what room is required for the coil, and what will be the weight of wire in it if the limiting conditions of heating or waste of energy are to be fulfilled.

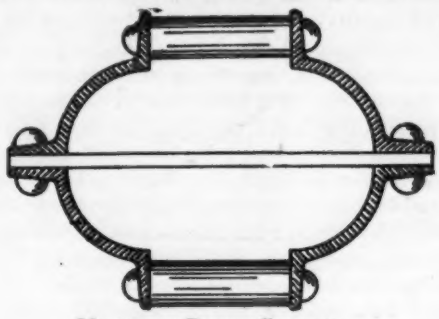
Take first the case in which the heat limit applies. The energy wasted must in this case be proportional to the surface of the coil. If we allow a cooling surface of 2½ square inches, reckoned on the outside of the coil only, for every watt transformed into heat, the rise of temperature in continuous running will be from 20 to 25 deg. C., and this may be taken as a perfectly safe and satisfactory limit. The following symbols will be used:

δ	Diameter of wire in inches.
L	Length of wire in inches.
D	Depth of winding in inches.
R	Resistance of coil in ohms.
τ	Number of turns of wire in coil.
π	Perimeter of coil in inches.
W	Energy lost in watts.
X	Exciting power in ampere-turns.
c	Current through wire in amperes.

The Engineer.

Neglecting for the present all numerical co-efficients, we can establish a series of equations between these various quantities. The number of turns in the coil must be proportional to its sectional area, and inversely proportional to the square of the diameter of the wire, or $\tau = \frac{L D}{\delta^2}$.

The resistance is proportional to the perimeter and number of turns, and inversely proportional to the square of the diameter of wire,



MILLIKEN POLE—SECTION.

$$R = \frac{\pi \tau}{\delta^2}.$$

The energy lost is proportional to the cooling surface,

$$W = \pi L.$$

It is also proportional to the resistance and square of current.

$$W = R c^2.$$

The exciting power is obviously given by the expression,

$$X = \tau c.$$

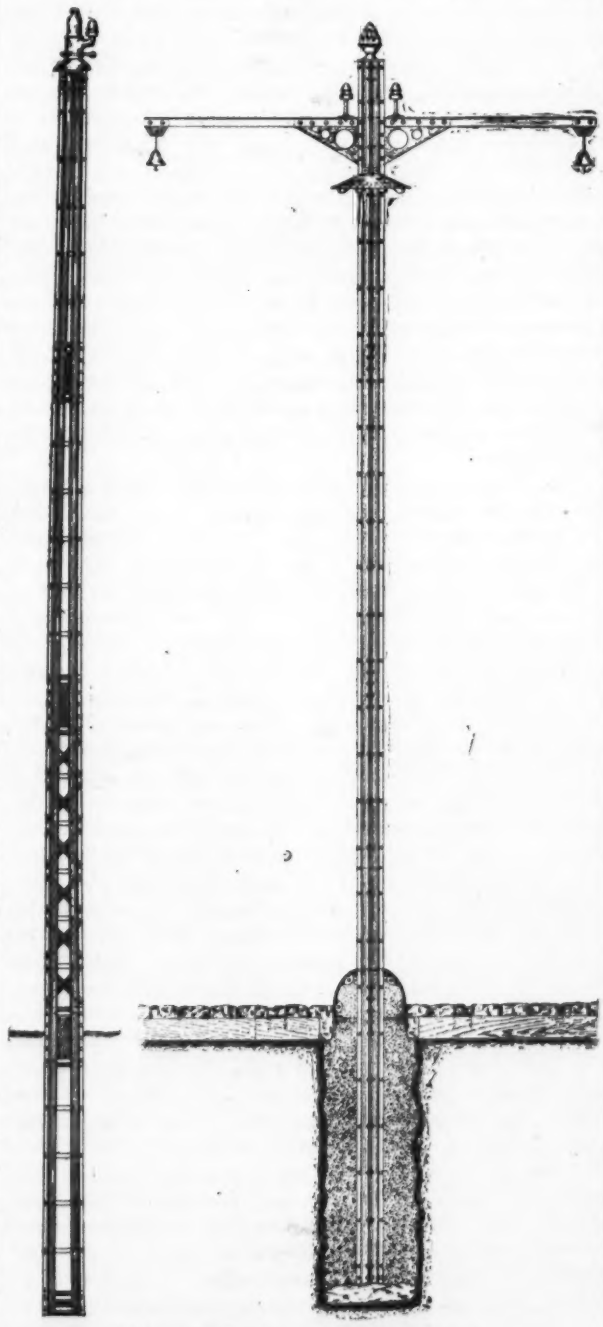
By combining these equations, we find

$$\pi L = \frac{\pi \tau}{\delta^2} c^2$$

$$\pi L = \frac{\pi X}{L D}$$

$$X = K L \sqrt{D} \qquad (1)$$

Where K is a coefficient depending partly on the size of the wire and partly on the general dimensions of the coil,



MILLIKEN SIDE AND CENTRE POLES.

that this coefficient cannot be a constant is evident from the fact that in the above equation we have taken no account of the ratio between the space wasted by insulation, both of the former and the wire itself, and the space occupied by copper. This ratio is obviously a variable one, the waste being the less, the larger is the whole coil and the stouter the wire. The size of wire has, however, more influence upon K than the general dimensions of the former, and since, in the usual run of designs, the larger coil is generally wound with larger wire, we may determine K merely with regard to the size of wire. In designing a machine we know beforehand, within 15 or 20 per cent., what will be the diameter of the wire to be used for the field, and can therefore hit upon the value of K at once, provided we have determined K for various sizes of wire. To use formula (1) we must therefore have a table giving this value, and it is best to prepare such a table by reference to machines actually built. The table here given has been calculated for a cooling surface of 2.5 square inches per watt:

Diam. of bare wire in mils.	K.
40	522
120	542
200	570

It will be noticed that the variation in the value of the coefficient is comparatively small, so that a large error in the first guess as to the diameter of the wire to be used only results in a very small error in the final result. Equation (1) gives the exciting power obtainable with a coil L inches long and D inches deep. It can, of course, be brought into another form, so as to give the depth or length of a coil for any desired exciting power.

The weight of a coil can also be expressed by a general formula, at which we arrive in a way similar to that pursued in arriving at equation (1). It is not necessary to give the method in detail. The result is—

$$\text{Weight in lbs.} = K \frac{\pi}{L} \left(\frac{X}{1000}\right)^2 \qquad (2)$$

In this equation K is another coefficient, which must be determined with reference to the gauge of wire used and the cooling surface allowed per watt. Where this is 2.5 squares inches, we find the following table:

Diam. of bare wire in mils.	K.
40	.495
120	.520
200	.615

It will be seen from equation (1) that an increase in the length of the coil is more effective in augmenting the exciting power than an increase in its thickness, while equation (2) shows that the weight is diminished as we increase the length of the coil. It will be understood that the coefficient in (1) is only correct for the ratio of 2.5 square inches of cooling surface per watt. If a different ratio is adopted, the coefficients must be altered. Let q be the new ratio, then K for this ratio is found by multiplying the value of K given in the table by $\sqrt{\frac{2.5}{q}}$. Thus, if the ratio adopted is 5 square inches per watt, then K for 120 millimetres will be $\sqrt{\frac{2.5}{5}}\,542 = \frac{542}{1.41} = 384$.

Taking, now, the more general case, in which we settled beforehand what amount of energy we can afford to waste in excitation, we use the above formulæ with the exception of $W = \pi L$. We thus find, neglecting again all numerical coefficients—

$$W = \frac{\pi \tau}{\delta^2} c^2$$

$$= \frac{\pi \tau^2 c^2}{L D}$$

$$= \frac{\pi X^2}{L D}$$

Introducing now a coefficient, K, we have

$$X = K \sqrt{\frac{W L D}{\pi}} \qquad (3)$$

In this case, when the loss of energy is fixed beforehand, the exciting power is proportional to the square root of the depth of the coil, as in the other case; but it is also proportional to the square root of the length, and not to the length directly, as in the other case. An increase of length or an increase of depth will therefore be equally efficient. To get a compact design of machine, short coils are desirable; and where economy of exciting energy is of first importance such coils can conveniently be used. Where, however, the temperature limit is of first importance, long coils are cheaper than short ones, and then the design of the machine will be less compact, and the iron part of the field will be heavier.

As regards the numerical value of the coefficient K in equation (3), this, of course, also varies with the gauge of wire. The following table gives it between the limits already mentioned.

Diam. of bare wire in mils.	K.
40	820
120	850
200	900

The weight of the coil is proportional to $\pi L D$. From (3) we find $X^2 = \pi W L D$, and multiplying both sides by π we have $X^2 \pi^2 = W \times$ weight.

Introducing now a coefficient, K, and writing $\frac{X}{1000}$, instead of X, for convenience, we obtain—

$$\text{Weight in pounds} = K \frac{\pi^2}{W} \left(\frac{X}{1000}\right)^2 \qquad (4)$$

For a constant expenditure of energy the weight increases as the square of the perimeter and as the square of the exciting power. If both perimeter and exciting power

remain the same, the weight is inversely as the energy. The coefficient in (4) is as given in the following table:

Diam. of bare wire in mils.	K.
40	.195
120	.205
200	.246

Having by means of these equations found the dimentions and weight of the coil, it is an easy matter to find in the usual way the exact size of wire, turns per layer, number of layers, and resistance, according to the E. M. F. or the current available, as the case may be.

The Electric Light in Italy.

Greater advances in electric lighting have been made in Italy than in any other European country, and it is noticeable that most of the installations employ alterrating currents and converters. The following table shows the importance of the principal Italian stations, with the power used and the systems of converting:

Cities.	Capacity of Station in Watts.	Power used.	Converter.
Rome	1,440,000	Steam.	Zipernowski.
Rome-Tivoli	800,000	Hydraulic.	do.
Livourne	240,000	Steam.	do.
Palermo	40,000	Steam.	do.
Venice	160,000	Steam.	do.
Milan	150,000	Steam.	do.
Syracuse	150,000	Steam.	do.
Cimeo	150,000	Steam.	do.
Turin	300,000	Steam.	do.
Trévise	60,000	Hydraulic.	do.
Terni	240,000	Hydraulic.	do.
Tivoli	6,000	Hydraulic.	Gaulard.
Bagni-di-Lucca	15,000	Hydraulic.	Zipernowski.
Taglicozzo	15,000	Hydraulic.	do.
Bassano	50,000	Hydraulic.	do.
Perdehone	30,000	Hydraulic.	do.
Abzano-Maggiore	100,000	Hydraulic.	do.
Schio	50,000	Hydraulic.	Kapp.

It will be seen from this that water power is largely utilized and that the Zipernowski system of converters has almost completely occupied the field.

On an Accidental Illustration of the Effective Ohmic Resistance to a Transient Electric Current Through an Iron Bar.*

BY SIR WILLIAM THOMSON.

The wonderful accidental experiment of Lord Armstrong may briefly be described as follows: A bar of steel which Lord Armstrong was holding in his hand, was allowed accidentally to come in contact with the two poles of a dynamo giving 85 ampères and 103 volts. A painful sensation of burning was instantly felt and the bar was dropped. Severe blisters occurred where the hand or fingers touched the bar, which was found immediately afterward to be quite cold, or not perceptibly hot. This marvelous incident proved: (1) the outer surface of the steel to have been intensely heated; (2) that not enough heat was generated to sensibly warm the whole bar. The explanation, of course, is to be found in the known laws of diffusion of electric currents through non-magnetic conductors, considered in connection with the effect of magnetic susceptibility, of unknown amount and law, in conductors of steel and iron.

The requisites for working out fully the theory of transient or periodic currents in conductors of any form are included in Maxwell's fundamental questions, and are given explicitly for straight cylindric conductors of non-magnetic material in sections 685-689 of his work. Lord Rayleigh, in his paper "On the Self-Induction and Resistance of Straight Conductors" (*Phil. Mag.*, May, 1886), gives the formula for transient or periodic currents in straight cylindric rods of iron, on the supposition of constant magnetic susceptibility. The details of this highly interesting and important branch of the subject have also been investigated by Heaviside in a very comprehensive manner. The tendency of periodically alternating currents to be condensed on the outer part of a cylindric conductor, while the current may be exceedingly feeble or quite insensible in the central parts, was discussed and explained by Lord Rayleigh in p. 388 of his article already referred to, and its aggravation in an iron conductor specially pointed out. The same considerations show that a transient current resulting from the application, for a very short time, of the electromotive force of a voltaic battery, or of electro-magnetic induction acting not directly on the cylindric conductor considered, but on a conductor such as the inductor of a dynamo of any kind, momentarily in circuit with it, is only skin deep if the duration of the electromotive force be but short enough; and that the depth to which the current penetrates in a given very short time is much smaller for iron than for copper.

To find something toward a mathematical solution for the increasing current at any instant during the electric contact of Lord Armstrong's experiment, it is convenient first to consider the problem of finding the subsidence of current initially given in a circuit of two long parallel bars connected by end bridges, or in a circuit of two long bars insulated, within a conducting sheath, except at its ends, which are in metallic connection with the sheath. If afterward we suppose the conductors and one end bridge to be given with no current, and that a voltaic battery giving constant potential be suddenly applied instead of the other end bridge, the rise of current through the parallel conductors from its initial zero to its ultimate steady amount will follow *nearly* the same law as the fall from the initial steady current to the final zero in our former simple case. The law will, indeed, be *exactly* the same if the quantity of positive electricity on one conductor and of negative electricity on the other, requisite to charge them as a condenser in virtue of the gradient of potential, is nothing in comparison with the quantity flowing through the circuit. The quantities of electricity set in motion in consequence of electro-static and electro-magnetic induction vary considerably in relative importance, according to the problem considered. For many telegraphic and telephonic problems the static charges are by no means negligible, and in the ocean-cable problem they are of paramount importance, the electro-magnetic induction with which we are now occupied being in this case quite negligible. In shorter cables, and with high-speed action, both the electro-static and the electro-magnetic induction must be taken into account, and both have been practically considered by Heaviside in the mathematical theory of the telephone. In the vast majority of laboratory arrangements, the currents required for the static charges are quite negligible, as is also the case with Lord Armstrong's experiment, so that the problem is reduced to considering the natural subsidence of a current under the action of no electromotive forces save those induced by its own rate of change.

In all cases of electric currents given in parallel straight lines, and left to subside, naturally the thermal analogy is most convenient. For electric conductivity, we have thermal capacity divided by 4π; for magnetic permeability, the reciprocal of thermal conductivity; and for current density, temperature multiplied by thermal capacity. Thus, if two infinitely long straight parallel conducting bars, separated by insulating material, be given with equal currents in opposite directions through them, and left to themselves, we have precisely the same mathematical problem to solve as if in every line of the thermal analogue we had initial temperature multiplied by thermal capacity given equal to the current density in the corresponding line of the electro-magnetic problem, and the system left to itself, with the positive and negative temperatures in the two bars subsiding toward zero. The quantity of heat generated per unit of area per unit of time, at any point of either interface in the thermal analogue, is equal to the rate of variation per unit of length along the electric conductor of the electrostatic force in the insulator in contact with it in the electric analogue. The fall of temperature in the latter case will correspond in some respects with the diminution of current in the former, and the rise of current in different portions of the conductor when suddenly subjected to an applied electromotive force will correspond with the rise of temperature in different parts caused by the sudden exposure of the surface of the body to a high temperature.

The case of a bar of circular section surrounded coaxially by a hollow circular cylinder is next to be considered. To further simplify matters it is further supposed that the conductivity of the sheath is very great. The problem then becomes mathematically the same as that of a heated cylinder allowed to cool, which was presented and fully solved by Fourier in the sixth chapter of his "Théorie Analytique de la Chaleur." The numerical values to be taken in representation of the various physical properties of the material are then considered. Thus the permeability of the steel is taken as 300 by way of example and illustration; but as the permeability varies enormously with the amount of the magnetizing force, and in a manner desperately complicated by hysteresis, no accurate mathematical investigation is practical with only our present knowledge to guide us. The conclusion arrived at in this particular case is that during the first $\frac{1}{4000}$ of a second, the diffusion is unaffected by the curvature of the conductor, and follows sensibly the law of plane laminar diffusion. The supposition of the circular cylindric sheath of negligible resistance, adopted for the sake of simplicity, may accordingly be departed from, since the solution will be nearly the same for the case of two parallel rods, provided the distance between them is a considerable multiple of the diameter of either. Although the circumstances in Lord Armstrong's experiment are of such extreme complexity that it is of no use to attempt to work out a complete mathematical theory, it seems very probable that the solution thus indicated fairly illustrates the circumstances of the current which actually flowed through the steel bar. At all events, ample explanation of the intensity and suddenness of the effect perceived by Lord Armstrong is obtained by working out the result numerically of what would take place if a difference of potential of 100 volts were suddenly instituted, and forcibly maintained constant during one, two, or three ten thousandths of a second between the ends of the bar.

It must not, however, be supposed that the difference of potential between the ends of the bar was in reality constant at 100 volts, even for so short a time as this. What was really constant was the strength of current through the electrodes leading from the complex dynamo circuit of armature, and shunt and series coils of the electro-magnet, to the external lighting circuit, and to the temporary circuit through the steel bar. The immense quasi-inertia of each partial circuit within the dynamo, prevented any great augmentation of the outgoing current during the few hundredths of a second during which the short circuit occurred, and, with probably no practical error, it may be supposed that the outgoing current was constant at 85 ampères, the electric lighting circuit losing as much current as that which was passing through the bar. Since the quasi-inertia of the lighting circuit was very small, it seems quite probable that the whole of this current for the first few thousandths of a second passed through the outer skin of the steel bar. There is thus no difficulty in understanding the origin of the sudden high temperature of the surface which Lord Armstrong perceived, and yet that the whole amount of heat generated was insufficient to heat the bar to any sensible degree. If the dynamo had been doing no work externally at the time of the accident, the time required to get up a strong enough current out of the dynamo to produce much heating effect would have been very much longer than it was.

* Abstract of paper read before the Royal Society of Edinburgh March 17, 1890.

John George Halske.

The death is announced in Berlin, at the advanced age of 76 years, of the well-known engineer John George Halske, at the time of his death a member of the Municipal Council of the city in which, 46 years previously, he had founded the mechanical works that became famous among electricians as the site of the labors of Werner Siemens. The association of Siemens and Halske, begun in 1847, lasted until the retirement of the latter in 1867. Each was great in his own department, and the death of Halske removes one of the stepping-stones upon which modern engineering advanced to the wonderful position it now occupies.

Gas-Engines for Electric Lighting.

To the Editor of The Electrical World:

In an editorial article on page 265, of The Electrical World for April 19, 1890, you use the following language: "We reach the rather remarkable result that a given amount of gas will give more light through the medium of a gas engine and dynamo than it will directly." This is an exact statement of the fact, and its importance has been much underestimated. The difference is due to the fact that in burning gas for illumination the light rays, which are the only ones of any use, are only those that are, so to speak, supported upon the vast body of heat rays beneath. The latter produce no useful effect, but in a lighting device are a positive injury. In an electric light the proportion of light rays to the *dead* heat rays is much greater than in the combustion of gas, so that it is a positive gain to burn the gas for the heat rays alone, which is done in a gas engine, and use this motor to drive a generating dynamo, which in turn produces a light so much richer in light rays that these will more than compensate for the loss due to double conversion. The proportion of light rays is, of course, especially large in arc lights. With a plant approaching that of a full-sized gas plant the economy would be very surprising to most persons. In letters patent of mine covering this mode of utilization in certain details, granted in 1888, I point this out in the following language (page 3): "It is also known that gas burned for illumination greatly preponderates in the heat rays, which yield no light, over the light-giving rays; while the reverse is the case with electric lights, so that a very great economy is obtained by burning common illuminating gas to drive an engine, which in turn operates an electric generator to furnish the light, and much more when a low-priced fuel gas is used, not costing more than 25 cents per 1,000 feet, and in many cases much less."

I would refer also to a statement made on page 534, of the United States edition of 1886, of Urbanitsky's "Electricity in the Service of Man": "Large gas engines produce one horse power by the consumption of a cubic metre of gas per hour. With such an engine, by using the electric arc light, a light of 1700-candle power can be obtained; but if this quantity of gas is consumed by ordinary gas burners, only seven flames of 10-candle power each are obtained, *i. e.*, a light of 70-candle power. It is therefore possible that the electric light may gradually take the place of gas, although gas will not become useless."

It is stated in the same work, page 476, that Professor Tyndall had determined that of a gas flame only 4 per cent. of the rays were light rays, while in a voltaic arc the proportion was 10 to 11 per cent. Our best modern arc lights give much higher results to-day, as well as the incandescent lights, which in efficiency approach them far more nearly than gas. Any observer knows that the loss of heat in burning gas is far greater than in an incandescent lamp. In a gas engine the heat is what is wanted, for which there are 93 per cent. of its rays available, while for illumination there is barely 4 per cent. The future of electric lighting is closely bound up with the problem of economical gas engines, for the gas can be generated cheaply, and conveyed long distances with little loss, and, finally, utilized at far more than cent-per-cent in available values.

Isaac W. Heysinger, M. D.
1426 *Girard Avenue, Philadelphia.*

Chancellor Gibson's Knoxville Decision in Favor of Electric Railways.

The East Tennessee Telephone Company vs. The Knoxville Street R. R. Company.

This is a suit brought by the telephone company to enjoin the railroad company from using the earth as a return electric circuit, and from interfering with the electrical condition of the air, to its injury.

The telephone company claims:

(1) That it has a grant from the city to erect poles and string wires in, over and along all the public streets and alleys of Knoxville;

(2) That it has such posts and wires, and is doing a telephone business;

(3) That the railroad company is about to use electricity as a motor, with the earth for a return circuit;

(4) That the telephone company is now using the earth for its return circuit;

(5) That both companies cannot so use the earth at the same time, as the telephone current is too delicate to contend with the railroad current;

(6) That the railroad company's wires are also liable so to affect the electricity in the telephone wires, or are liable so to charge the air with its electricity, as to interfere with the very delicate electrical currents used by the telephone company;

(7) And that the telephone company has a "vested right" to the "exclusive use" of the earth and the air as against every person using the same for electrical purposes to the detriment of its telephones.

For these reasons the telephone company has obtained a temporary injunction against the railroad company inhibiting the latter from using the single trolley system or any other system that uses the earth for a return circuit.

To this bill the railroad company has put in a sworn answer, setting up, among other defences, the following:

(1) The ordinance under which the telephone company claims its rights does not vest in it any such rights as it claims.

(2) That what rights the ordinance does give are not the property of the telephone company.

(3) That the railroad company's electrical appliances will not injure the telephones;

(4) And that if they should, the injury can cheaply be remedied.

On this answer, the defendant moves the court to dissolve the injunction.

On the hearing of this motion, the affidavits of many electrical experts have been read, much electrical literature has been offered, not a few judicial opinions have been cited, and most able and elaborate arguments have been made. The whole subject of electricity has been brought before the court, including a miniature telephone plant and a miniature electric car and electric railroad, so that Menlo Park itself seemed, in miniature, before the court. The main questions for determination presented by the pleadings are: 1st, were such rights as the telephone company claims conferred upon it by the city of Knoxville; 2d, if so, are they exclusive and monopolistic in their nature?

On examining the bill I find that the telephone company avers that on Oct. 22, 1880, it was "granted the right and privilege to erect its poles in, over and along the public streets, alleys, lands, roads and public squares of the city, to string its wires thereon, and to use and operate the same for the purposes of telephonic and telegraphic communication;" and that relying on said franchise it has constructed a telephonic plant and is now operating the same.

This averment is the foundation of the telephone company's right and claim to relief; and the truth of this averment is doubly denied by the railroad company, which says that no such franchise was granted and that what was granted was granted to the telephone *exchange* and not the telephone *company*. On examining the ordinance of the city I find it reads as follows: "Be it ordained, etc., that the privilege of erecting poles on the public streets and alleys of Knoxville be granted to the East Tennessee Telephone Exchange, and this privilege of erecting posts shall be confined to telephone exchange purposes exclusively. That the posts erected shall in no way interfere with the public travel along the streets, sidewalks and public alleys of the city. That nice posts, straight and smooth, be required, and that the same be in line with the outside edge of the curbing."

To an impartial mind this ordinance does not seem to "grant the right and privilege to erect poles in, over and along the public streets, alleys, lands, roads and public squares of the city." The ordinance confines the location of the poles to the streets and alleys, and says nothing whatever about "lands, roads and public squares;" nor does it say the poles may be erected "in, over and along the public streets, etc.;" it says "on" the streets and "in line with the outside edge of the curbing." Neither does the ordinance say a word about any right "to string wires" on said poles, or about "using and operating the same for the purposes of telephonic and telegraphic communication."

I mention these matters for the purpose of ascertaining what rights were granted by said ordinance—to measure their comprehensiveness. The bill claims practically unlimited rights to erect poles, string wires, and "use and operate the same" "in, over and along" all the "public streets, alleys, lands, roads and public squares" in the city; whereas, the ordinance merely gives the "Exchange," not the company, the "privilege of erecting poles on the public streets and alleys, ... this privilege to be confined to telephone exchange purposes exclusively."

It must be remembered that the telephone company does not claim any particular right of way, or strip or piece of ground, or any particular streets or alleys, within the limits of Knoxville for its earth circuit, but it claims the whole of the surface of the earth, and all that is beneath the surface of the earth, within the corporate limits, as its exclusive property for all the purposes of an earth circuit.

Now, if at the time this ordinance was passed, any one had suggested that this limited privilege of "erecting poles" gave the Telephone Exchange a right to use all the ground on which the city stood, public and private, as an easement to be used in place of wires, to complete its electrical circuit, he would, no doubt, have been regarded as a wilful distorter of language. But if, in addition, he had claimed that this meager privilege of "erecting poles" not only gave the Telephone Exchange a right to use all the ground, public and private, within the corporate limits, as its own, but the right to use it to the exclusion of all other electric companies from now to the ending of the world, he would have been regarded as a wicked exaggerator, if not a deliberate falsifier. And yet this is exactly what the telephone company claims in its bill.

I am unable so to construe this scant "*privilege* of erecting poles" as to make it "grant the right" to the exclusive use of every inch of ground within the corporate limits, for all the purposes of an earth circuit for electricity. Such a grant could never have been in the minds of the Mayor and Aldermen; and I am unable to find these exclusive rights and monopolistic powers condensed in five such harmless words as "the privilege of erecting poles."

The telephone company, however, does not content itself with literally claiming the exclusive use of the whole of the earth on which Knoxville is built, for its return electrical currents, but it claims a monopoly of the whole air also, and insists that no other electrical company can string its wires in the near neighborhood of the telephone wires. And thus the simple privilege of "erecting poles" on the side of the streets of Knoxville is magnified into a grant of the exclusive right to all the earth and all the air within the corporate limits of Knoxville, for all electrical purposes, except telegraphing.

But it may be urged that the ordinance says that "this privilege of erecting poles shall be confined to telephone exchange purposes exclusively." So it does; but will it be contended that these words, which are rather words of limitation than of extension, give the telephone company the exclusive right to use every inch of Knoxville's ground and a superior right to all its air, as its private property for electrical purposes?

And thus it is, this once humble telephone company, that was given the bare privilege of "erecting poles" on the edge of the curbing, now comes forward, and, by virtue of those two talismanic words, claims the right to make the electric light companies, the electric railroad companies, and all other electric companies, for all time to come, keep their wires from communicating with any part of the ground on which the city stands or else pay it for the privilege of so doing. In a word, it claims a perpetual monopoly of the earth upon which the city is built for all the uses of an electrical circuit; and also claims a superior right to the air itself, for electrical purposes.

Ordinarily a person's strength consists of his physical power, but the telephone company's strength is sought to be derived from its weakness: it says that its electrical current is so weak that all strong currents greatly affect and impair its usefulness, and that, as a consequence, no company using a strong current can lawfully use the earth for a return circuit without its leave. If this contention be correct, then no electric company can ever use the underground on which Knoxville is built without the consent of the telephone company. It makes no difference what grand discoveries and inventions in the use of electricity may be made. Coal, wood, gas, steam and animal power may all be superseded by electrical devices, machines may be invented to heat and light all of our homes, do all of our cooking, propel all of our vehicles and machinery, and all or a large part of this electricity may be drawn from the earth, or it may be drawn from the air, and yet Knoxville and her people are to be denied all of these wonderful benefits for all the ages to come, if they, either through the earth or through the air, in any way cripple or injure the feeble current of the telephone company, unless the telephone company gives or sells its consent.

The streets of Knoxville are held in trust by the city for the benefit of the people, to the end that the people may have the right to walk and ride and transport goods and animals, and propel vehicles over and along them. And the city has no right to allow the streets to be used for any purpose inconsistent with these rights of travel and transportation. Telephone poles have no connection with travel or transportation, and have no just rights on our street, and are, at best, mere tenants at will. These doctrines were distinctly recognized by the city when it granted this privilege of "erecting poles," the ordinance emphatically providing that "the posts erected shall in no way interfere with the public travel." It may be said the trouble grows not out of the "posts" but out of the "wires." To this it is answered that the word "wire" is not in the ordinance, and all the right the telephone company has to use wires is as an incident to the post, and what the ordinance means is that neither the posts nor the wires on them shall, in any way, interfere with the public travel. In other words, this privilege of "erecting poles" or posts, is to be, in every respect, subordinate to the use of the streets, for public travel. If this be the meaning of the ordinance, then the city has the right to allow electricity to be used as a motor for the propulsion of street cars, and if the telephone poles or wires "interfere with the public travel" on these electric cars, the city has a right to have them removed. And, on this ground, also, it will thus be seen that instead of the telephone company having exclusive and monopolistic rights both to the earth and to the air for electrical purposes, it is a mere humble occupant of the streets, by permission of the city, and liable to be declared a nuisance whenever its poles or wires interfere with the public travel.

Fast, indeed, must our rights be slipping from us, and most insecure, indeed, must be their moorings, when such claims as these are countenanced by the courts. I have, heretofore, declared in a suit between the defendant and the city, that our streets are public property under the trusteeship of the Mayor and Aldermen, and very slowly and very reluctantly will I ever decide that any of the property of the people has become the fee of any one person, whether such person be a Kentucky corporation or one native born.

I might go further and show that there is no evidence or allegation that the E. T. Telephone Company, a corporation under the laws of Kentucky, is the E. T. Telephone Exchange that acquired this privilege of "erecting poles." The answer denies their identity, and the ordinance supports the answer. In the light of the present claims of this telephone company to the benefit of this ordinance, and to the monopoly of ground on which the city stands, for all the purposes of an earth circuit, I can only say that if such was its object when it secured the apparently humble privilege of "erecting poles," it was seeking to perpetrate a fraud upon the city of Knoxville, whose Mayor and Aldermen could not have supposed that they were selling the birthrights of their constituents for less even than a mess of pottage. The courts must see to it that no public grants, and no privileges granted, shall so be construed as to deprive the people of any rights or powers except such as are expressly stated or necessarily implied. In applying this rule I hold that the ordinance referred to did not give the telephone company any such exclusive right as it claims; and I am further of the opinion that under its charter powers, and under the corporation ordinance, the Knoxville Street Railroad Company has the right to propel its cars by the single trolley electric system, or by any other the city has authorized or may authorize.

HENRY R. GIBSON, *Chancellor.*

The Senate Committee on General Laws.

The N. Y. State Senate Committee on General Laws continued its investigation on April 22 at the Hotel Metropole.

Henry S. Kearney, engineer of the Board of Electrical Control, was the first witness, and he gave some very valuable testimony. Mr. Kearney said he had been for four years supervising the construction of the subways, and had had special opportunities of noting the extent to which the gas system affected the question now at issue. The gas companies had gridironed the city with their mains. In some streets there were four sets of mains on each side of the street — in Sixth avenue, for instance, from Fourteenth street, north — while in a large number of other streets there were from two to four sets of gas mains on each side of the street. The cause of this was that each new company had organized a new plant, and had, of course, laid down its own line of gas mains. These mains were from 4 to 20 inches in diameter. Most of them were laid down over thirty years ago, and as they were originally, when new, of poor and cheap material, it need not be wondered at that they are now not only rotten, but frequently nothing more than a crust of rust round a hole in the ground. Another disadvantage was that these pipes were of uneven thickness. They had been cast horizontally, and the consequence was that the half-inch pipes would be three-quarters of an inch thick on the under side and only a quarter of an inch thick on the top. Now-a-days all pipes are cast in a vertical position. The average life of a pipe was about twenty years.

The Subway Company had paid for a great many miles of new piping. When in the construction of the subways the old rotten pipes were met with, they were taken out, and the gas companies relaid the mains at the expense of the Subway Construction Company. Out of all the pipes that it had thus been found necessary to interfere with, there were not 5 per cent. that did not leak. The effect of this leakage was to permeate the soil with gas, and thence it passed into the subways and sewers, and was always available for an explosion if the igniting spark was around. Another effect of this leakage was to put the Subway Company to considerable expense in maintaining a system of ventilation so as to keep the subways clear and safe. Probably the most serious source of trouble was the service pipes connecting the houses with the mains. A new company would come in and offer better terms than the old one to the householder. The old line would be superseded by the new line, and the old connections by the service pipe leading from the main were broken. In some cases it would be broken off short close to the main, and the gas would be allowed to escape at its own free will.

Another very serious source of trouble to the underground wires, the witness stated, was the escape from the steam heating pipes. The temperature in the soil of lower Broadway, say from Howard street to Exchange place, was invariably far over 100 degrees, and the consequence was that no insulation would stand there. The effect of this heat and moisture on buildings was also very serious; the cement in the masonry was caused to decompose rapidly, and it crumbled away and weakened the foundations of the buildings. Mr. Kearney's testimony was strikingly corroborative of a large amount of the most trustworthy testimony brought out by the investigation of the Board of Electrical Control last year into the cause of the subway explosions.

James W. Smith, President of the Consolidated Gas Company, said that his company had been formed by the amalgamation of six original companies. Two of these had been in existence over 50 years, and two over 30 years. The escape of gas was mainly owing to the disturbance of the pipes by the excavations of the Subway Construction Company and the steam heating companies. The actual leakage, however, was inconsiderable, probably nearer one per cent than ten. As to the large discrepancy between the amount manufactured and the amount consumed, that could be accounted for by shrinkage.

The first witness at the session of the 26th was Gen. Daniel E. Sickles, who testified to the excessive waste of gas.

The witness alluded to the fact that a strong smell of gas has been frequently observed in the streets of the city for several years. It constituted a nuisance and was inimical to health. The proper remedy was to hold the company responsible for the nuisance just as a private individual would be held. If the law did not give the power to do this it should be amended.

A. A. Knudson, electrical engineer of New York and St. John, N. B., said he made a careful investigation of the various systems of electric street railways in order to make a report to the St. John Street Railway Company, which was under the control of New York capitalists, and he finally recommended the overhead single wire trolley system as the most practicable and effective. There was absolutely no danger to life in this system, as the voltage used was not enough to be dangerous. There would be no danger in using iron poles, even if they were not insulated from the trolley wire, which they were, on account of their making a perfect ground connection. When asked under what restrictions overhead wires should be constructed in order to prevent any accidents from wires falling across them, Mr. Knudson said he was of opinion that where a number of wires were crossing the crowded streets of a large city, the trolley wire should be protected by guard wires, both above and at the side, in order to obviate all possibility of danger from fire to which the contact with a falling telegraph or telephone wire might give rise, or the chance of shock to men or animals. No hard and fast line could be drawn for the regulation of these guard wires. Conditions were varied so much in different places, that what would be wise in one place would be injudicious in another.

D. Lowber Smith, ex-Commissioner of Public Works, testified that the Public Works Department had no control over the laying down of the gas pipes. The mains in the principal streets were in an infamous condition. The soil of the city was thoroughly saturated with the escaped gas, and in some places if a crowbar were driven down and taken out, and a light put to the hole, the gas that rushed out would ignite and burn brightly.

Various other witnesses testified to the enormous leakage of gas. Mr. Beckwith, chief engineer of the Consoli-

dated Telegraph and Electrical Subway Company, gave a graphic description of the dangers of subway explosions. He said the leakage in the lower part of the city was about 20 per cent., and in the upper part about 12 per cent. The leakage could be reduced to 3 or 4 per cent. One of the ways in which this could be done was to use wrought iron pipes wrapped in asphalt, as is done in Paris, where the saving in leakage pays for the extra cost of the mains.

The committee adjourned to the 3d prox.

Special Correspondence.

NEW YORK NOTES.

Office of The Electrical World,
167-177 Times Building, New York. April 26, 1890.

The spring meeting of the Magnetic Club was held at Martinelli's Tuesday evening, April 22. It was a well attended and pleasant reunion. Gen. Wager Swayne, A. H. Brown and G. H. Usher were the guests of the evening.

A New Dynamometer, and a very efficient one for obtaining the draft of machinery, is that recently devised by Herman Kohlbusch, manufacturer of fine balances and weights, 59 Nassau street. By attaching one end of the dynamometer to a motor car and the other to some firm object, and then starting the motor, its pull can readily be obtained in pounds from the reading on the face of the instrument.

Hydraulic Presses for Electrical Work.—The large hydraulic presses manufactured by Watson & Stillman, 204 East Forty-third street, are meeting with much favor among manufacturers. They are used for heavy electrical work, such as cutting with dies the plates for storage batteries, etc. This firm also makes a specialty of hydraulic jacks, of which they have recently shipped a large bill to the Edison Company.

The Continental Dynamo Company, 63 Broadway, have have done nearly $50,000 worth of business since Jan. 1. They have equipped their new factory in Dover, N. J., with machinery of the latest design, and are manufacturing dynamos and motors. They are very busy installing plants in this section of the country. Their general manager and electrician, Mr. Peter Claus is to be congratulated upon the success with which he has met in introducing his continental system of electric lighting.

The C. & C. Motor Company, of New York, have published a list of their recent sales. The list shows a large area of territory covered by the sales of this company and a widely varied application of heir motors. They have supplied them for use in running elevators, ventilators, coffee mills, lathes for wood workers and for jewellers; to run the entire machinery of a shop, to blow the organ in a church, to run a saw and a sewing machine. The motor is a good one, and the company is prospering.

Simplex Wires.—W. H. Gordon & Co., 115 Broadway, are doing a large trade in Simplex wires, cables, etc. They have lately disposed of 75 miles of this wire, of which 40 miles was of the best T. Z. R. insulated wire, and went to the large electric light plant now being installed by the gas company in Jersey City. They are selling largely to railroad systems also. They have a very handy current indicator, too, which, by being placed over a line wire, immediately indicates the direction of the current.

Alternating Currents.—A lecture on "Alternating Current Apparatus for Central Stations, its Use and Arrangement" was recently delivered before the Swedish Engineers' Club, of New York, at the club rooms, 320 Sackett street, Brooklyn, by one of the members, Mr. Olaf Offrell of the United States Illuminating Company, of this city. Westinghouse and Slattery alternating current apparatus were exhibited in illustrating the lecture, as were also the drawings for a universal switchboard for 30,000 lights designed by the lecturer, who claims that when completed this will be the largest switchboard in the world.

The New Dry Battery that is being sold by Himmer and Anderson, 20 Vesey street, seems to be giving very satisfactory results, and is finding large sales. Mr. Himmer, who was connected with the earliest form of the dry battery, expresses himself enthusiastically with regard to the working of this, his latest production, and invites for his battery the severest tests. The batteries are made in various sizes, and are especially recommended for open circuit work. When new they test 1.8 volts and 8 ampères with low internal resistance. The manufacturers recuperate the batteries if they become run down from accidental closed circuit, and they supply material for recharging.

James H. Mason, Manufacturing Electrician, 63 Broadway, manufacturer of the James H. Mason primary battery for domestic electric lighting and running motors for general use, reports great success in the sale of his batteries. The Empire City Electric Company, 15 Dey street, are agents for these batteries, and have placed some large orders. The Novelty Electric Company, of Philadelphia, are agents also. W. T. Knox, 257 South Fifth street, Brooklyn, after a series of successful tests of these batteries, has taken an agency. Mr. E. J. Dubeau, of the province of Quebec, Canada, was at the office of Mr. Mason while these facts were being mentioned, and stated that he has become so satisfied with the operations of these batteries as to take the agency for Canada.

The Daft Electric Light Company, 115 Broadway, are making special efforts to secure contracts for electric railway and power plants. They secured a contract for four miles of track and three motor cars for the city of Gloucester, Mass. Reeds Lake, Grand Rapids, Mich., have closed with them for three miles of track and two motor cars. They are constantly adding valuable improvements to their system. One in particular is a trolley hanger and support for a double wire, which can be locked solidly to a transverse support wire. The Daft Storage Car, with Gibson batteries, Toledo, O., averages 120 miles with two sets of batteries, and carries an average of 550 passengers per day; it has carried 700. This record is from the daily report taken by the Consolidated Street Railway Company of Toledo, O., and was sent to the Doft Company.

W. T. H.

NEW ENGLAND NOTES.

Branch Office of The Electrical World,
Room 8, Cook Building, cor. Franklin and Congress Sts.
Boston, April 16, 1890.

Montello, Mass.—An electric street rail is projected between this place and Campello.

Pittsfield, Mass.—An electric street railway will soon be built between this place and Dalton.

Natick, Mass.—The Natick and Cochituate Street Railway contemplate important extensions.

Plymouth, Mass.—A Chicago capitalist is considering the building of a rival street railway in this place.

Waltham, Mass.—The Newton Electric Railway Company has recieved a franchise to run their cars through several streets of this city.

Bangor, Me.—The Street Railway Company are about to make a considerable extension of their present system and run their cars over several additional miles of track.

Bridgeport, Conn.—The Star Electric Company has been organized here and will immediately begin the manufacture of all kinds of electrical apparatus.

The Mason Regulator Company of Boston is receiving large orders from abroad. Almost all the firms who send the orders mention The Electrical World.

Plantsville, Conn.—At the annual meeting of the Connecticut Motor Company, the following officers were elected: R. E. Duston, president; S. Blakeslee, Jr., treasurer; J. R. Staff, secretary.

Exclusive Franchise.—Dover, N. H., has granted an exclusive franchise to the Consolidated Light and Power Company to erect poles and wires. The Union Street Railroad, between Great Falls and Dover, will be begun at once. It is to be completed before July 1.

Newport, R. I.—It is probable that the wealthy cottage owners here will form an electric light company for the purposes of lighting their own residences. The station will be located near Ochre Point.

Hartford, Conn.—The Eddy Electric Company have been placing new machinery in their shops. The business of this company has increased so rapidly that they find they need more room, and it is reported that an extension to the building will soon be added.

Plantsville, Conn.—The Connecticut Motor Company reports the following sales for week ending April 26: One 10 h. p. for Boston; one each 1 h. p., New York & Scranton; one ½ h. p. and one 5 h. p., Philadelphia; one 5 h. p., Rochester, N. Y.; one 3 h. p., Cincinnati, O.

The Electric Club, of Boston, Mass., held an informal reception for ladies at their rooms on Park Street last week. The occasion was of a social nature, and the two hundred people present spent a very enjoyable evening. The feature of the reception was the exhibition of phonograph and phonographic dolls.

New England Electric Exchange.—At the annual meeting at Boston this week officers were chosen as follows: President, Alexander P. Wright (managing director of the Wright Electric Engineering Company, Boston); secretary and treasurer, H. H. Fairbanks; directors, E. H. Hewins, H. C. Spaulding and W. S. Hill.

Boston, Mass.—The Evans Friction Cone Company has opened a branch office in the Hathaway Building.—The Johnston Electric Train Signal Company are arranging to erect a new factory.—The New England Electric Company, sole New England agents for the Sprague Electric Railway and Motor Company, has removed to its new offices, No. 2 Post-Office Square.

Whitman, Mass.—The company that is to construct a local railway between this place and Boston must, by the provision of its charter, begin work on or before May 1. No steps in this direction have yet been taken owing to the company's inability to effect a contract with the directors of the east side of Brockton, over about a mile of whose road the new line will pass.

A New Zinc.—The Electrical Improvement Syndicate, 7 Exchange Place, Boston, control the output of a new zinc, the important feature of which is its amalgamation, the mercury being incorporated into one homogeneous mass, making its life three times as long as ordinary amalgamated zinc. The internal resistance is very much less, while the electromotive force is increased. The zinc will be made in all sizes and forms, and can be applied to any battery.

The Brown Protector Company, Smith, Johnson & Dasham, 54 Devonshire street, Boston, agents, are making many sales of their protectors. It has the indorsement of the Boston inspectors and many of the leading railway and telegraph companies. They claim that the protector does its work in a superior manner, affording protection against a wide range of dangerous currents, and presenting no weak contacts whereby the service of any line may be impaired.

Massachusetts.—An act was recently passed in the House of Representatives compelling mills and factories to adopt some electric device whereby the engine or machinery may be immediately stopped in case of accident to employés. This act was passed to provide for the temporary absence of the engineer. It was demonstrated by at least one device shown to the committee that the engine could be stopped more promptly by electricity than by the engineer in the ordinary manner.

The Electrical Safety Company, Boston, is pushing the Cartwright protector for saving electrical instruments against injury from accidents due to electric light wires crossing lines connected with them, and similar causes. So long as the current passing through the instrument is normal the armatures of the protector remain free, but on the passage of a large current they are attracted and the magnetic forces are grounded. The instrument is said to work admirably.

The Thomson-Houston Electric Company has issued its annual report for the last fiscal year. This report shows 587 companies using the system for 68,203 arc and incandescent lights in this country alone. It also has about 400 incandescent lighting companies which operate between 300,000 and 400,000 lights. This report does not include isolated plants. For the street car system over 1,000 cars are reported as in process as the result of the last two years' work. The volume of business seems to be satisfactorily increasing, and the financial condition of the company is said to be distinctly better than at the end of last year, a large surplus being reported as on hand. The total paid up capital and surplus is stated to be $7,185,415.

Hartford, Conn.—The Hartford Dynamic Company, agents for the Russell Automatic Engine Company, of Massillon, O., receive very encouraging reports from their numerous installations of the Russell engine. Their own dynamic switch is also meeting with a large demand.——The Southern New England Telephone Company, under the direct supervision of General Superintendent E. B. Baker, will replace all the iron poles on Main street from South Green to the tunnel, a distance of two miles, with eighty three pine poles 75 feet in height. They are also doing large underground wire work, having a contract to place 60,000 feet of underground conduit.——The John Pratt Company are erecting a new factory, 225 by 40 feet, two stories high, which they hope to occupy by Aug. 1.——Captain Brophy, of the Mutual Insurance Company, is making a trip through New York, New Jersey, Pennsylvania, Ohio, Indiana and several States, examining stations in the interest of his company.

L. H. H.

WESTERN NOTES.

Branch Office of The Electrical World,
465 The Rookery, Chicago, April 26, 1890.

St. Jose, Cal.—The electric street railroad system has been put in operation.

Ideal Engines.—Mr. A. L. Ide, of Springfield, Ill., is in the city closing up some important contracts for Ideal engines.

Mr. B. B. Kerr, Chicago, has lately secured several contracts for Westinghouse apparatus from parties in Michigan.

Organization.—The Citizens' Telephone Company has been organized at Cuero, Tex., by G. J. Schieches, J. M. Hamilton, R. A. Pessants and others.

Lansing, Mich.—The Westinghouse Electric Company has obtained the contract for equipping a complete street car line with the Westinghouse motor.

The Colby Electrical Specialty Company has been incorporated at Chicago, capital stock, $100,000. Incorporators, E. J. Colby, S. A. Merrick, David Aaron.

Suit Dismissal.—The Thomson-Houston Electric Company, of Topeka, Kan., has dismissed the suit against the Topeka Rapid Transit Railway Company for the collection of $86,000 of the bonds of the company and the appointment of a receiver.

Cleveland, O.—The Hill Clutch Works secured the contract for supplying the shafting, pulleys, etc., in the Rand-McNally building Chicago, through their Chicago manager, Mr. Charles B. Coon.

Denver, Colo.—Albert Sechrist has purchased the half interest of I. H. Beardsley in the firm of Albert Sechrist & Co., and sold one-quarter interest in the said business to M. C. Marshall, of Greely, Colo. The firm still continues under the name of Albert Sechrist & Co.

Quincy, Ill.—The Electric Wheel Company has been incorporated, with a capital stock of $25,000, to manufacture wheels by the use of electricity. Incorporators, S. H. Enery, Jr., Thomas Hill and C. G. Comstock.

Topeka, Kan.—The Pacific Coast Electric Supply and Construction Company, for constructing and maintaining electric railroads; incorporators, F. G. Hentig, W. W. Manspeaker, Byron Roberts and J. R. Hankla, of Topeka, and D. McFarland, of Los Angelos.

The Automatic Electric Exchange Company, of East St Louis, Ill., has been incorporated, with a capital stock of $100,000, to manufacture electrical apparatus. Incorporators, W. H. Ford, A. Leslie and H. Overstolz.

The Storage Battery Car has begun regular trips on the Fort Wayne & Elmwood line, Detroit, Mich., and will, until further notice, cross Woodward avenue at intervals of an hour, commencing at 10:15 A. M. and continuing until 5:15 P. M.

New Factory.—Ground was broken yesterday for the new factory to be erected on the southwest corner of Woodward avenue and Baltimore avenue, Detroit, Mich., just above the Woodward avenue railway crossing, by the Detroit Electrical Works Company.

Foree Bain, of Chicago, is sending out a letter-head of unique design, informing the reader that in addition to being an electrical engineer, and expert electrician, he makes a specialty of adapting electricity to new uses, and also builds complete systems of mining, hauling and electrical apparatus to order.

A New Line of Porcelain Goods, cut-out boxes, ceiling rosettes and switches is being brought out by Mr. George Cutter, 80 Adams street, Chicago. Mr. Cutter has been very successful in handling specialties for light and power plants through being thoroughly competent personally to test them before sending them out.

J. L. Lang & Company, Chicago, have recently shipped several hundred of their Andrews switches of large carrying capacity to various incandescent plants, notably to the Museum of Natural history and to the Metropolitan Museum of Art in New York City; to the government printing office in Washington; to Tarrytown, N. Y.; Passaic, N. J.; Des Moines, Iowa, and Martinsburg, West Va.

Kreibel Steam Engine.—The Rice & Whitacre Manufacturing Company, Chicago, are receiving many orders for their Kriebel steam engine with double cylinders, for use in driving small dynamos for isolated lighting. These engines were fully described and illustrated in The Electrical World of Sept. 19, and their merits are acknowledged and appreciated wherever power ranging from 1 to 30 h. p. is desired.

The Electrical Supply Company, 171 Randolph street, Chicago, are pushing the sale of their fibre insulating cleats. These cleats possess advantages over the ordinary wood cleats sufficiently apparent to insure their ready adoption and extensive use. The openings spring together so that the cleats may be fastened on before being put up, and the saving in time will equal the difference in cost. The cleat is a good insulator, will not absorb moisture, and being smaller and neater than wood cleats, affords a much better appearance.

Obituary.—Mr. Edwin S. Hewson, late superintendent of construction of the Chicago office of the United States Electric Lighting Company, died of pneumonia at his residence, 236 La Salle avenue, Chicago, on Saturday evening, April 19. Mr. Hewson was 27 years of age; was born in Newark, N. J., where the body was taken for interment, and was the second son of Commissioner Theodore Hewson. Mr. Hewson was a member of the Chicago Electric Club, and a committee of its members was appointed to take suitable action.

Chicago, Ill.—Mr. Samuel E. Nutting, electrician of the Nutting Electric Manufacturing Company, 248 West Jackson street, has invented several important devices in addition to the arc lamp shown on page 284 in our last issue, and which has already attracted the attention of capitalists as well as electricians. A compact, symmetrical motor, designed by Mr. Nutting, was shown on page 197 of Vol. XIV. of The Electrical World, and we hope soon to have the pleasure of illustrating a new type of alternating dynamo that Mr. Nutting has just constructed.

Telephone Quotations.—Col. S. G. Lynch, broker, 146 La Salle street, Chicago, furnishes quotations on telephone stocks as follows:

Chicago	$290	@$295	Cumberland	$ 59	@ $60
Central Union	60	@ 61	Wisconsin	116	@ 117
Michigan	97	@ 98	Bell of Missouri	140	@ 145
Great Southern	30	@ 32	Iowa Union	21	@ 25
Colorado	38	@ 40	Missouri and Kansas	54	@ 55
Rocky Mountain Bell	40	@ 45			

ELECTRIC LIGHT STOCKS.

Chicago Arc Light and Power	$97	@$98	Chicago Edison Co. $115 @$117

The Electrical Supply Company, 171 Randolph street, Chicago, recently placed a new dry battery on the market, which they say will sustain itself in any contest of merit. The elements of the Ajax battery are securely mounted in a strong metal case, and require very little attention. It is claimed to have a high

electromotive force, little resistance, and to recuperate its energy very completely and rapidly. They solicit a test of its merits and utility for the operation of bells, annunciators, burglar alarms, and for all open circuit work. There are no glass jars to break, no salts to creep, no solution to prepare or spill. In height the cell is but six inches, three inches in diameter, and weighs but two and three quarter pounds.

Removals.—Mr. G. A. Edward Kohler, manager of the Chicago office of the Eddy Electric Manufacturing Company, has moved his office to room 329 The Rookery, in order to be nearer the field of action.—Mr. H. S. Walker, manager of the Western department of B. W. Payne & Sons, the Wainwright Manufacturing Company, the Hall Steam Pump Company, etc., is now occupying the handsome stores at Nos. 26 and 28 West Randolph Street, Chicago.

Cleveland, O.—The conduits for the projected cable roads are now being built, and by Fall this city will see horse cars, cable roads and two overhead electric systems working side by side. Possibly the much-talked-of storage battery cars for the Woodland Avenue line will also be in operation.—Some Englishmen who were in the city last week admired the slender tubular iron poles that carry the electric light wires on Euclid Avenue. Their expressions here offset that of Mr. Adenbrooke, who told the British Institute of Electrical Engineers last December, that "during his whole journey from San Francisco to New York, he could not recollect having seen one ship-shape, neat and smart-looking post used for any electrical purpose." The neat poles, set in an exact line, with the cross-arms clamped squarely and the wires drawn taut, certainly do not detract from the beauty of one of the finest streets in the country, and the steady white arc lights make a pleasing sight in the evening. The latter are of the new short arc Brush type.—The drop of potential at one car when another is approaching it is often noticed here. On one of the shortest single track roads in this country, the operators are shrewd enough to use this as a guide to meeting at the turnouts. They can tell by the brightness of the lamps just how far off the next car is, and so change the speed of their motors as to make as good connections as if they were in plain sight of each other.

Electrical Decision, Burlington, Ia.—The case of the Great Western Telegraph Company, E. R. Bowen, receiver, vs. Hiram Purdy, was decided in the District Court Saturday, April 19. This case is of great importance to many in Iowa. In 1867 to 1869 many citizens of this State subscribed to the capital stock of the company or believed they so subscribed from the representations made to them by the agents at the time. The company soon thereafter contracted a large indebtedness, and being insolvent, passed into the hands of a receiver in 1874. In 1886 an assessment of 35 per cent. of the stock was made by the court at Chicago, and the receiver brought this, the first action in Iowa, to collect the amount. The intention is to sue all the subscribers in Iowa. There were many defenses pleaded, and the issues involve many intricate questions of law. Judge Phelps gave the case a thorough consideration, and decided in favor of the defendant. The case will probably be taken to the Supreme Court as a test case by the receiver.

The Brush Electric Company, of Cleveland, O., are equipping central stations with their alternating apparatus, as follows: Jeffersonville, Ind., Electric Light Company, 600 lights; S. & J. C. Atlee, Fort Madison, Ia., 1,000; Red Bank, N. J., Electric Illuminating company, 1,000; Marysville, Cal., Coal Gas Company, 1,000; Evansville, Ind., Gas and Electric Light company, 1,000.

For arc light stations they have sold the Hampton, Va., Electric Light Company apparatus for 30 lights, and one for 100 to the Haverhill, Mass., Electric Company.

Isolated arc plants have been sold to J. P. Witherow & Co., New Castle, Pa., 30 lights; Cleveland Rolling Mill Company, 30 lights; Michigan Agricultural College, Lansing; C. S. Robinson, Princeton, N. J., and steamboats owned by R. D. Blair, Osceola, Miss., and St. Louis and Mississippi Valley Transportation Company.

Brush motors have been furnished to Princeton College and Beecher Furnace Company, Cleveland, an isolated power plant to the Dayton, Tenn., Coal and Iron Company; also a motor for hoisting purposes at Aspen, Colo., of the new 440-volt constant potential type, a plating dynamo to the Taylor and Boggis Foundry Company, of Cleveland. F. DE L.

WASHINGTON NOTES.

Post Office.—Two of the stamping machines used in the city Post Office are run by ¼ h. p. C. & C. motors.

Navy Yard.—The electrical experts of the Bureau of Yards and Docks have completed their tests of the electric light plant of the Washington navy yard, and are preparing their report. The tests were highly satisfactory in every respect.

Increased Appropriation.—The Senate (District of Columbia) appropriation bill contains an item: "For electric lighting on one or more of the principal streets of the cities of Washington and Georgetown, including the south side of Pennsylvania avenue, one arc light for Freedman's Hospital, and one for the asylum, $50,000." This is an increase of $5,000 over the House bill.

Electricity for Athletes.—The new club-house of the Columbia Athletic Association is now supplied with electric lights. The plant consists of 400 incandescent lamps supplied from the central station of the United States Electric Light Company. The installation was made by Mr. John R Galloway, contractor, under the supervision of Mr. C. W. Mesner. The club-house was thrown open to the public for the first time last evening.

Electric Musical Machine.—Mr. W. E. Wood, employed in the office of the architect of the Capitol, has invented an electric musical machine. The keyboard is similar to that of an ordinary type-writer, the keys of which are connected electrically with a number of electric bells arranged beneath the table. Pressure upon each key closes the circuit of an electric bell, and when the keys are operated by one previously prepared, any tune may be played on the machine.

The Sprague Motor Company.—It is rumored that the agencies of the Sprague Motor Company will shortly be abolished throughout the country, and branch offices established in their stead. This company, through its agent, Mr. R. B. Smith, has done an excellent business in this city in the two years the agency has been established. During that time over 40 installations of motors have been made, ranging from 1 to 15 h. p. In connection with the agency Mr. Smith runs a fully equipped machine shop, the machinery of which is run by a 10 h. p. Sprague motor.

Naval Appropriation for Electricity.—The naval appropriation bill as it passed the House contains the following items: For lighting by electricity the U. S. S. "Lancaster," $10,000; for an electric welding machine for the Boston navy yard, $12,000; for an electric light plant at the Mare Island navy yard, San Francisco, $45,000. A bill is now before the Committee of Naval Affairs of the House which provides for the appropriation of $250,000 for experimenting with electricity as a motive power in its application to marine architecture.

Electric Street Railways.—The bill amending the charter of the Elkington Electric Railroad Company, so as to permit said company to extend its lines from its present terminus, Seventh street and New York avenue, to Fifteenth and "G" streets, has passed both Houses of Congress, and now goes to the President for signature in order to become a law. Work on the extension will be begun immediately.

A clause has been inserted in the District of Columbia Appropriation Bill by the Senate to allow any of the street railroad companies, whose charters now provide for horse cars, to increase their capital stock should they adopt a cable or electricity as a motive power. It is expected that several if not all of the street railroad companies, will make a change. The Metropolitan Company has already begun experiments with a view to changing from horse to storage batteries. A storage battery car was recently tested on that company's lines. The battery consisted of 120 cells, 60 on each side of the car. Two motors were used on each car of 12 h. p. each, one on each side of the car. The motor was designed by Mr. C. O. Mailloux and Mr. F. H. Chamberlain. The Detroit Motor Co. is going to compete for supplying a street car truck for this company. An equipment will be sent here shortly to be tested, and many advantages are claimed for it. The motor runs continously, and is coupled by means of a friction clutch. It is guaranteed by the company to run 35 miles with out recharging, when storage batteries are used.

S. E. D.

SOUTHERN NOTES.

Cedartown, Ga., will soon establish an electric light plant.

Atlanta, Ga.—The electric street railways are discussing the advisability of consolidating.

New Braunsfels, Tex.—The Landa Electric Light and Power Company has been organized.

Gadsden, Ala.—A company is being formed for the construction of an electric street railway.

Charleston, S. C.—The telephone exchange has just been augmented by the introduction of an 800-wire switchboard.

Raleigh, N. C.—The owners of the street railway are contemplating the substitution of electric motors for their present horse power.

Greenboro, N. C.—Temple College is to be lighted by incandescent lamps, and is busy negotiating for the purchase of the necessary outfit.

Buckhannon, W. Va.—A company has been organized by G. W. Fleming, G. A. Newton and others to build and operate an electric light plant.

Greensboro, N. C.—The city council has contracted with the Gaynor Electric Company, of Louisville, Ky., to furnish the city with an electric alarm system.

Memphis, Tenn.—A company is being formed here with $100,000 capital stock to manufacture and rent the Harvey Patent Electric Circuit closing instrument.

Rockville, Md.—The electric light company recently formed at Rockville, Md., is looking around for a suitable plant, and expects to begin operations very soon.

Demorest and Cornelia, Ga., are to be connected both by telephone and electric street railway. Eventually the telephone wire will be extended to Porter Mills, Clarksville, Tallulah and Toccoa Falls.

Suit Against the Western Union Company.—Atlanta, Ga.—A. A. Murphy has brought suit for $100 damages against the Western Union Telegraph Company, alleging culpable delay in the delivery of a message.

Electric Weighing and Printing Scales.—Several of the electric weighing and printing scales have been put in restaurants and hotels at Memphis, Tenn., during the past week, by the Weighing Scale Company of Chicago.

Consolidation.—The three electric street railways, and the three electric light companies of Richmond, Va., have been consolidated under the title of the Richmond Railway and Electric Company, which was chartered by the Virginia Legislature at its last session. Six of the directors of the new company have been elected. Mr. George B. Fisher, who has practically directed the consolidation, will probably be elected president.

Alabama.—Recent decisions of the Supreme Court of the State of Alabama will lead one to infer that a resident purchaser of goods may justly plead violation of statutes when sued for the value of his purchases, if the firm or corporation so selling have not in the office of the [Secretary of State an instrument under its corporate seal and the official signatures of its president and secretary designating at least one known place of business in the State, with an authorized agent or agents residing thereat.

Baltimore, Md.—Mr. S. Carlidge has been appointed by Secretary Windom to the position of superintendent of the electric light plant of the recently completed Baltimore public buildings. The City Council of Baltimore have adopted an ordinance authorizing the Mayor, Comptroller and Register to contract a sum not exceeding 40 cents per light per night for a term of three years, with the lowest responsible bidder, to light the streets of that city with electric lights. Proposals are to be invited by advertisement, and will be opened June 2. The contract is to take effect Oct. 2.

Injunction Refused.—The Augusta and Louisville Street Railway Company recently applied for an injunction to restrain the Augusta Street Railway Company from building an electric road in Augusta, Ga. The old company claimed that under the original charter granted by the Legislature, and by the contracts and ordinances of the city, it had the exclusive right to all the streets for railroad purposes. In giving decision the magistrate before whom the case was tried said that the old company had exclusive rights for a street railway using animal power, but that it had no exclusive right as to the cars propelled by electricity. motor power having been discovered and introduced since the original charter and contracts with the city went into effect. The injunction prayed for was consequently refused. The new company is constructing 15 miles of electric street railway in the city and suburbs. It is composed of capitalists from Kansas City, and is a strong organization.

Atlanta, Ga.—At a meeting of the City Council the Committee on Electrical Construction submitted a report upon the petition of the Citizens' Electric Light and Power Company, operators of the Ball system of electric lighting, asking for the privilege of erecting a steam electric lighting power station, with the necessary circuits. The committee recommended the granting of the petition on the condition that "the petitioners commence work in erecting their plant within one hundred days from the granting of the privilege, and provided that, should they at any time sell their plant to a competing company, one already or at that time in working order, then all the unnecessary wires, poles and construction obstructing the streets or alley ways of Atlanta shall be immediately removed at the company's expense. In granting this petition the city gives no franchise that can be sold to and held by other parties without authority from the city, within the 100 days that are named in the petition; and, furthermore, should the above-named company fail to begin work within the time specified, hen all rights hereby granted shall be declared forfeit. The petitioners are to place all wires and overhead construction on poles now in use on the streets for similar electrical uses, and shall have the right to condemn constructions now in place for that purpose if a fair and equitable agreement cannot be arrived at; and where present poles are not of sufficient height, size and strength to carry the required wires, new poles are to be substituted, and none but first-class straight cedar poles to be used." The council adopted this report, and the company, thus equipped, will at once proceed to business. Y. N. B.

ENGLISH NOTES.

(*From Our Own Correspondent.*)

LONDON, April 16, 1890.

Chelmsford.—The first town in the United Kingdom the streets of which are lighted throughout by electricity is the small country town of Chelmsford, the public lighting of which began on Monday night. The lighting has been undertaken by Messrs. Crompton & Co. It comprises 18 arc lamps and 200 incandescent lamps, the total annual cost being £873. There is to be a fine of 4d. per lamp for every arc light that goes out, and ½d. per lamp for every incandescent lamp that does so. A complete failure of the light is to be punished by a fine of £500.

The Submarine Telegraph Company.—The concession of this company, which owned the cable connecting England with the Continent, was terminated somewhat summarily by the governments concerned in the spring of last year. The price paid for the companies' cables, whose length amounted to 370 statute miles, was only £22,330, or £60 per mile. As most of these cables were in good working condition, there was naturally some outcry at this ridiculously low price, and strenuous efforts were made to obtain a better, but all to no purpose. In the result, however, the shareholders of the now defunct company have not done so very badly. By the sale of the reserve fund securities, leasehold properties, steamers, electrical instruments, etc., the liquidators have been able to return the capital to proprietors in full, and now announce a further distribution of 7 per cent., still leaving in the hands of the liquidators a balance of over £3,000.

Municipal Authorities and Electric Lighting.—The announcement that the Board of Trade has decided to insert in the Provisional Orders applied for by municipal authorities a clause permitting them to transfer their powers to the first comer, divesting themselves at the same time of all legal responsibility in the matter, has caused some astonishment in electric lighting circles in this country. Provisional Orders applied for by municipal authorities were already granted in preference to those applied for by companies, and this preference has enabled municipal authorities to impose somewhat onerous conditions upon companies desirous of obtaining electric lighting powers. With the additional privilege now granted them, municipal authorities bid fair to have the entire control of electric lighting in Great Britain. If the ventures are successful they will take them over, while should they turn out failures the "undertakers" will have to bear the brunt. The next twelve months will show us whether, in their eagerness to obtain the profits without the risks, our municipal authorities will not go far to extinguish electric lighting enterprise in England.

Incandescent Lamp Experiments.—Mr. F. Higgins recently read a short paper before the Institution of Electrical Engineers on the diathermancy of air in relation to the efficiency of incandescent lamps. He took a number of lamp bulbs, fitted with precisely similar filaments of platinum-iridium. Some of these bulbs were exhausted to the highest possible degree, some were exhausted to a pressure equal to 1-10 inch of mercury, and some were left open to the air. First of all, Mr. Higgins brought the lamps to the same degree of red heat. To produce red heat in the air bulb 7 watts were required, in the 1-10-inch vacuum 5.3 watts, in the highest possiple vacuum, .466 watts only. Placing the three sorts of filaments in series, the air bulb filament was scarcely heated at all, with a current that raised the filament in the 1-10 inch vacuum to dull redness, and that in the highest possible vacuum to white heat. When the same filaments were raised to incandescence, that in the air bulb required 31.2 watts per c. p., the 1-10 inch vacuum 15.2 per c. p., and the highest possible vacuum 4 watts per c. p. These results show what an important effect an imperfect vacuum may have on an incandescent lamp.

The Grievances of Telegraph Operators.—In the House of Commons last night Earl Compton rose to call attention to the grievances of the telegraph operators, and formulated these grievances in a speech of such a studiously moderate character and of such irreproachable accuracy that the Postmaster-General, on rising to reply, congratulated Earl Compton on his statement. The grievances of the telegraph operators in this country may briefly be summed up as: Too long hours, insufficiency of pay, slow promotion and insufficient time to take their meals. The Postmaster-General stated that the telegraph clerks had entered the service with their eyes open, and he could hold out no hope of any substantial increase in pay or of diminution of the hours of labor. A departmental committee was, however, sitting, and he anticipated that it would be able to formulate a scheme of departmental re-organization which would tend to mitigate the numerous small but vexatious grievances complained of by the telegraph operators. He deprecated in warm terms the increasing tendency to call in the aid of members of parliament in obtaining concessions from the heads of government departments. He believed that in the great republic across the water, which they were always being called upon to imitate, "every inhabitant in the District of Columbia was disfranchised in order to prevent the employment of political machinery in departmental questions, and although that was a very drastic measure, it showed that American politicians recognized the danger that arose in cases like the present." Earl Compton's motion was eventually rejected by a majority of 39 in a house of 245 members.

THE ELECTRIC LIGHT.

Brunswick, Ga., is about to inaugurate an additional electric lighting system.

Troy, Ala.—An electric light plant is to be erected by parties from Montgomery.

Brenham, Tex.—An electric light plant is to be erected and operated by the city government.

The Tudor Iron Works, of East St. Louis is about to install a 100-light incandescent plant.

The Union Pacific Railway Company is about to put in a 150 light plant at Anaconda, Montana.

Darby, Pa.—The Home Electric Light Company has been incorporated, with a capital stock of $2,500.

Clifton Heights, Pa.—The Citizens' Electric Light and Power Company has been incorporated, with a capital stock of $25,000.

Carrollton, Ga.—A company has been formed entirely with home capital for the purpose of erecting an electric light plant.

Fort Edward, N. Y.—The capital stock of the Fort Edward Electric Light Company is now $12,000, all paid in.

St. Louis, Mo.—Carroll & Powell have purchased complete Thomson-Houston lighting outfit for two steamboats.

Franklin, Tenn.—The plant of the Franklin Electric Lighting Company has been completed and put in operation.

The Tonawanda and Wheatfield Electric Company, of Tonawanda, N. Y., has been incorporated, with a capital stock of $50,000.

New Contract.—The Oldtown Electric Light Company has contracted with the town of Oldtown, Me., to furnish 16 arc lights for $1,000 per year.

Parkersburg, W. Va.—The city government is said to have in contemplation the early erection of an electric light plant for street illumination.

The Gloucester (Mass.) Electric Company has been granted permission to erect poles and run wires for electric lighting at East Gloucester.

The Marysville Electric Light and Power Company, of Marysville, Cal., will erect a plant. It is probable the Thomson-Houston system will be used.

The Lycoming Electric Company, of Williamsport, Pa., will put in five 60-light alternating arc dynamos and one 950-light alternating incandescent dynamo.

Goshen, Ind.—The Citizens' Electric Company succeeds the Goshen Electric Light and Power Company. Woodson V. Messick, president; A. J. Irvine, secretary and treasurer.

The New Brighton Electric Light and Power Company has been organized by East St. Louis, Ill., capitalists, and incorporated under the State law, with $20,000 capital.

Orange, Mass.—The business of the local electric light company has increased to such an extent as to demand the addition of a new engine. They will put in one of 150 h. p. capacity.

Belleville, Ill.—The St. Clair Steam Supply & Electric Light Company is now the Electric Light and Coal Company. John Brosius president; Geo. W. Knobelock, secretary and treasurer.

Trenton, Ga.—The Trenton Electric Light and Power Company has been incorporated, with a capital stock of $30,000. Incorporators, J. T. Morrison, J. K. Fullerton and Frank Douglass.

Big Stone Gap, Va.—The Thomson-Houston Electric Company has been awarded the contract for the erection of an electric light plant for the Big Stone Gap Improvement Company.

Mr. J. M. Denniston, of the Chicago office of the Westinghouse Electric Company, has secured the contract for the large incandescent plant in Libby, McNeil & Libby's new building.

Increase of Capacity.—The Pottstown Light, Heat and Power Company, of Pottstown, Pa., will increase the capacity of its plant by the addition of one or two new dynamos and another engine.

Albion, N. Y., was lighted with electricity for the first time last week, to the delight of its citizens. The Westinghouse system is used, and the plant is built in the most modern and complete style.

Woburn, Mass.—The local electric light company will shortly install two new dynamos in its central station to enable it to supply current for light and power purposes to Winchester and Stoneham.

St. Thomas, Ont.—The Westinghouse Electric Company has just closed an order for a 750 light incandescent outfit. The St. Thomas Gas Company is the buyer. The plant is to be installed at once.

The South Side Electric Company has been incorporated at Chicago, to furnish light and power. Capital stock, $500,000. Incorporators, William J. Buckley, Monroe L. Willard, Henry M. Wolf.

The Milwaukee Light and Power Company, of Milwaukee, Wis., has been incorporated, with a capital stock of $500,000. Incorporators: J. J. Kempf, W. H. Earles and Chas. Stolper.

The Union Electric Light and Power Company, of Union, Ore., has been incorporated, with a capital stock of $100,000. Incorporators: J. W. Shelton, W. R. Hutchinson and R. W. Purdum.

The New Electric Light Plant, at Fairmont, W. Va., is now assured. All the stock has been subscribed, and the plant will be constructed at once. The town is to be lighted by 1,200 c.p. arc lights.

Douglassville, Ga.—The Douglassville Electric Light Company has been organized, with a capital stock of $15,000. They will build a large dam and use water power. They start with 300 incandescent lamps.

Concord, N. H.—The cars on the new electric street railway will be mounted on trucks supplied by the Tripp Anti-friction Journal Company, and will be fitted also with the Tripp Company's special journal bearings.

New Brunswick, Tex.—The Landa Electric Light and Power Company has been incorporated, with a capital stock of $30,000. Joseph and Harry Landa, of New Braunfels, and Dr. Harry Wise, of Chattanooga, Tenn., incorporators.

The Collinsville Electric Light, Heat and Power Company, of Collinsville, Ill., has been incorporated, with a capital stock of $25,000, to furnish electric light, heat and power. Incorporators—Louis Lunagh, George Hatfield and T. J. Thomas.

Mt. Carmel, Pa.—The Edison Illuminating Company at a meeting of the Directors last week appointed a committee of four prominent citizens to secure the lease of or purchase a more suitable piece of ground with a view to doubling the capacity of the station.

Mount Morris, N. Y. is not a very big town, but the people who dwell in it are to have the advantages of electric lighting, nevertheless. An order was recently placed with the Westinghouse Electric Company. for a 500 light outfit for Mt. Morris, and no time will be lost in the installation of the apparatus.

Ouray, Colo.—The Ouray Electric Light Company, one of the oldest alternating current central station plants of electric lighting in the country, a few days ago contracted for an increase in its capacity. The Westinghouse Electric Company is now occupied in putting up one of its 750 light machines, making the total capacity of the plant 1,500 lights.

Sherman, Tex.—For some months a 750 light alternate current incandescent machine of the Westinghouse manufacture has been in use at this place. The company operating the machine is evidently well pleased with its workings, for it has just placed with the Westinghouse Electric Company an order for an additional machine of 750 lights capacity.

The Electric Light in Fire Departments.—The electric light is now being made a part of the equipment in fire departments. Lanterns containing incandescent lamps and weighing about 10 pounds, that furnish light for five hours, and headlights for the engines, using incandescent lamps run by storage cells, are being introduced by the San Francisco department.

The Thomson-Houston Electric Company have sold, through their Chicago office, to the Atchison Gas, Electric Light and Power Company a 300-light direct current incandescent dynamo; to the Aurora Electric Light & Power Company, a 35 arc light dynamo; to the Standard Stamping Company, of St. Louis, Mo. a 200-light direct current incandescent plant.

Fairfield, Ia.—The works of the Fairfield Gas and Electric Company comprise the old gas plant, and a new electric light station built on the site of the gas works. The new station starts in with a 70 × 60 feet steam plant and two Brush arc dynamos. A number of Bernstein lamps are run in connection with the arc lights, and incandescent lights will be added when there is sufficient demand for it.

Springfield, Mass.—The United Electric Light and Power Company a few days ago ordered from the Westinghouse Electric Company 3,000 incandescent lights to increase the present capacity of its plant. The United Company has in use Westinghouse dynamos of a capacity of more than 5,000 lights, and with the addition of the late order will have a plant of very considerable size.

Joplin, Mo.—A company composed of Kansas City and New Haven capitalists have bought the perpetual control of the water power at this place. The object is to utilize the water power for generating electricity with which to supply Joplin and Webb City with light. The mines near the city will also be lighted. About $70,000 will immediately be expended on improvements.

Long Distance Electric Lighting.—Brookline, Mass., and Johnstown, N. Y., are both going in for long distance electric lighting. The electric light companies at these places have just concluded contracts with the Westinghouse Electric Company for special machinery for long distance lighting. The Brookline plant is to have an apparatus of 900 lights capacity and Johnstown one of 500 lights.

Increase of Capital Stock.—Edison Electric Illuminating Company, of Newburg, N. Y., has voted to increase its capital stock to $60,000, and to issue $30,000 bonds, probably about June 1. The Queen City Electric Light Company, of Cincinnati, O., will increase its capital stock from $50,000 to $200,000. The Leetonia Electric Light and Power Company, of Leetonia, O., has increased its capital stock from $10,000 to $15,000.

A New Electric Light Company, of Susquehanna, Pa., held a meeting last week and elected the following officers: President, J. G. Brewer; Vice President, W. S. Mitchell; Secretary, A. W. Cook; Treasurer, C. F. Wright; Directors, J. J. Ahearn, Thomas Kelly, M. H. Eisman, C. F. Wright, J. G. Brewer, W. S. Mitchell, J. C. Cook. A committee was appointed to procure a suitable site for the plant, and it is expected that they will begin work within a week.

Going into Arc Lighting.—The Electric Illuminating Company, Evanston, Ill., the Joliet Electric Light Company, Joliet, Ill., and the Uxbridge and Northbridge Electric Company, Northbridge, Mass., all of which have been using the incandescent system, have placed orders with the Westinghouse company for arc plants. Orders are coming in rapidly for the new arc apparatus, and pleasing reports are received from those who have put them in. Martin's Ferry, Ohio, has ordered a 40-light machine from the Westinghouse company.

Consolidation.—The Consumer's Electric Light and Power Company and the Batavia Gas Light Company, both of Batavia, N. Y., are being merged into one company, which is now completely organized, viz: Consolidated Gas and Electric Company. Capital stock, $100,000. S. D. Purdy, president; Henry Craft, vice-president; Charles H. Caldwell, secretary and treasurer. The Reno Electric Light and Power Company, of Reno, Nev., has absorbed the Reno Electric Light Company. Capital stock, $100,000. W. G. Caffrey, secretary and manager.

Quick Work in Installing a Plant.—In Tennessee, recently, some quick work was done in installing a Thomson-Houston 30 arc light plant. The dynamo was shipped from Greenville to Rockville on April 18; on the 19th one gang of men was placed at work on the foundation for the dynamo, another at digging post-holes, and another at cutting poles in a wood about a mile distant. By 3:30 P. M. on the 23d the current was turned on over 2½ miles of wire and to twelve lamps. Every lamp worked perfectly. The whole job was accomplished in about 4½ days.

One Hundred Thousand Lamps.—The East End Electric Light Company is about to extend its operations to a degree that will make this city one of more light at night than any other in the country. The company will extend its operations to Hazlewood, Glenwood, Homestead and Sharpsburg. A plant will be built at the latter place, and President A. T. Rowand has bought four acres at Glenwood for a power-house there. Hitherto the company has not been able to serve all the territory it had contracted for, but this extension will cover its shorts. When the places mentioned are illuminated, Pittsburgh will be supplied with 100,000 incandescent electric lights, more than are in New York City at present—more than in any other city in the United States.

New Organizations.—At Rock Hill, S. C., a company is being organized for the purpose of erecting and operating an electric plant for street illumination.—The Camden Electric Light and Power Company has been organized at Camden, Ark., and has given the Thomson-Houston Company the order for an incandescent plant.—The Citizen's Light, Heat and Power Company, of Portsmouth, Va., has been organized, with R. M. Stuart-Wortley, president, and W. V. H. Williams, secretary.—The People's Edison Illuminating and Power Company, at Warwick, R. I., capital $30,000 has been organized, and the following officers elected: President, Hon. Hy. S. Greene; vice-president, John H. Campbell; secretary, Charles F. Hill; treasurer, Robert Reoch. The plant is an incandescent of 1,200 lights, and will be ready for use about June 1. Commercial and private lighting will be carried on at present, with street lighting in prospect. P. O. address, River Point, R. I.

The Thomson-Houston Electric Company reports the following sales of central station arc lights: Paris, Ky., 20; Maysville, Ky., 30; Miamisburg, O., 70; Lebanon, Ky., 30; Winchendon, Mass., 30; Sleepy Eye, Minn., 30; Nantucket, Mass., 30; New Philadelphia, O., 35; Mt. Sterling, Ky., 50; Narragansett Pier, R. I., 50; Greenwich, Conn., 50; Providence, R. I., 250; Seattle, Wash., 100; Great Falls, Mont., 100; Lawrenceville, Ind., 50; Yakima, Wash., 50; Atlanta, Ga., 100; Memphis, Tenn., 100; Reading, Pa., 50; Manitou, Colo., 30; Alma, Mich., 30; Freeport, Ill., 50; Ligonier, Ind., 20; Mt. Clemens, Mich., 30; Laredo, Tex., 100; Milwaukee, Wis., 35; Oakland, Cal., 35; Chicago, Ill., 38; Sacramento, Cal., 50; Terre Haute, Ind., 50.

Of central station alternating, Dyersburg, Tenn., 300; Cincinnati, O., 1,300; Pomeroy, O., 650; Winchendon, Mass., 650; Mt. Sterling, Ky., 650; Fall River, Mass., 650; Charleston, S. C., 650; Nantucket, Mass., 650; Greenwich, Conn., 650; Miamisburg, Ky., 650; Great Falls, Mont., 1,950; Marysville, Cal., 650; Denver, Colo., 650; Laredo, Tex., 1,300; Alma, Mich., 650.

In isolated plants: Salmon Falls Manufacturing Company, Salmon Falls, N. H., 100; Palmer Bros., Pittsville, Conn., 100; Bradford, Lewis & Sons, Walpole, Mass., 100; T. J. Stewart & Co., Oldtown, Me., 200; India Wharf Brewing Company, Brooklyn, N. Y., 400; C. F. Hovey & Co., Boston, Mass., 200; Pittsburgh Plate Glass Company, Tarentum, Pa., 800; Saxon Worsted Company, Franklin, Mass., 400; Sears Building, Boston, Mass, 400; Bijou Theatre, Boston, Mass., 400; Standard Stamping Company, St. Louis, Mo., 250; Luken's Iron and Steel Company, Coatesville, Pa., 20; C. F. Hovey & Co., Boston, Mass., 30; Lookout Mountain Hotel, Chattanooga, Tenn., 30; Castlegate Mine, Utah, 30; Claus, Sheer & Co., Fremont, O., 100; Beckell House, Dayton, O., 300; H. H. Hart, New York City, 600; Curtis & Bro., Newark, N. J., 50; Pierce, Butler & Pierce, Syracuse, N. Y., 100; Bendit, Drey & Co., New York City, 100; Luken's Iron and Steel Company, Coatesville, Pa., 100; John Kraus, Chicago, Ill., 300; Illinois Steel Company, Milwaukee, Wis., 50; W. G. Clark, Chicago, Ill., 300; G. F. Culmer & Bro., Salt Lake City, Utah, 150; J. Featherstone & Co., Chicago, Ill., 20; Osceola Gravel and Mining Company, Osceola, Nev., 3; University of Notre Dame, South Bend, Ind., 12.

APPLICATIONS OF POWER.

Leominster, Mass.—An electric street railway is projected for this place.

Austin, Tex.—The State printing office is putting in a 50-h. p. plant for light and power.

Hoosick Falls, N. Y.—The Hoosick Falls Electric Light and Power Company is now the Hoosick Falls Water Power and Light Company.

Milwaukee, Wis.—The appliances are to be put in to swing Grand Avenue bridge by electricity. The power will be furnished by the street car line.

Rome, Ga.—A movement is on foot here to purchase all the street railway and dummy lines of the city and establish a complete electric railway system.

New Bedford, Mass.—The New Bedford Iron Foundry has just added a 20 h. p. Thomson-Houston motor to their plant, thus increasing their force to 40 h. p.

Lexington, Ky.—The Central Electric Company is putting up a large power house from which to supply an electric railway and both arc and incandescent lamps.

Laredo, Tex.—The Laredo Improvement Company is erecting a large electric plant. When completed, it will be one of the most thoroughly equipped plants in Texas.

Another Electric Railroad.—It is reported that the Maysville (Ky.) Street Railroad and Transfer Company will adopt electric traction on its line, 3½ miles in length.

The Consolidated Electric Storage Company, of Orange, N. J., has been incorporated, with a capital stock of $3,000,000. Incorporators: R. C. Young, R. M. Robinson and C. A. Senin, Jr. The business is to be conducted in Camden and East Orange.

Large German Contract.—The Thomson-Houston International Company has lately closed a contract with the Bremen Tramway Company for six motors cars and two miles of electrical equipment. The same company will also furnish the Bremen (Germany) Tramway Company with six motor cars and two miles of electrical equipment.

Brooklyn's Electric Railway.—The electric branch of the Jay and Smith street roads in Brooklyn is now ready for operation. The power station at Kings's Highway and Coney Island avenue, Gravesend, is progressing rapidly toward completion. It will have a Babcock & Wilson battery, and boilers of 500 h. p. There will be four dynamos of 80 h. p. each.

Fort Worth.—Now that the city has reached an agreement with the United Edison Electric Company for the construction of a large power plant, the work on the same will be immediately commenced. The expenditure for these works will be not less than $30,000, and when they are completed the city will have its own property, the finest electric light plant in Texas.

The Mount Tabor Water and Electric Light Company has been organized by H. C. Campbell, C. F. Swigert, J. H. Smith, O. Royal and S. L. N. Gilman. The object of the company is to supply Mount Tabor and vicinity with water and light. A well will be sunk at the eastern base of Mount Tabor, and powerful pumps and engines and dynamos put in. The engines will pump water by day and run the dynamos by night.

Geneva, N. Y.—The electric street railway that has been so long talked of is now about to be put in operation. It will run over a belt line about 3½ miles in length. The people are more than ready to receive it, and there is no doubt that it will be a financial success. Indeed, already there is talk of an enlargement of the original plan, and a proposition will soon be made to run the cars over a mile or so more than at present is intended. The capital stock is $30,000, and outside parties are ready to take a part or the whole of it. Power will be furnished by the Geneva Brush Electric Light and Power Company.

Bellefontaine Electric Equipment.—The Bellefontaine street railroad, it appears, is soon to be equipped with an electric system, and placed on a first-class footing. On April 13 articles of incorporation were filed in Recorder Hobbs' office, for an organization to be known as The Motor Company, with a capital stock of $10,000. The stockholders are James Campbell, 49 shares; Emerson McMillan, 48 shares; J. C. Von Blarcom, John Scullin and Robert McCulloch, 1 share each. Mr. Campbell was asked what electric system would be used on the road, but he replied that he was making investigations of various systems, and had not yet decided which one was the best. The Thomson-Houston system, with overhead wire, however, seems to be regarded as the safest. The road will be equipped as soon as arrangements can be perfected.

PERSONALS.

Mr. H. Jyaraski, M. E., electrical engineer of the Ministry of Communications, Tokio, Japan, on a tour of inspection in this country, visited Boston last week.

Mr. Robert McA. Loyd, electrician of the Daft Electric Works, Jersey City, N. J., is visiting Mr. Frank J. Baker, the Chicago agent for the Daft Company.

Mr. Kenneth R. Stuart, an electric light engineer of London, who has for some years been connected with Latimer Clark, Muir

head & Company, is in this country, "looking the electrical field over."

Mr. H. L. Lufkin, of the C. & C. Motor Company, New York, has been visiting several of the Western towns, including Chicago, and returns to New York with some good orders in his inside pocket.

Mr. Sawyer, president of the New England Electric Company, has retired from active work. He is succeeded by Mr. George F. Steele. Mr. Steele is known for his assiduity and application to business.

Mr. Wm. T. Moore, of New York, well known in both the electrical and dry goods trade, is in Chicago closing up certain matters of business preparatory to widening the scope of his work in the electrical field.

Mr. George Atkinson, expert of the Chicago office of the Thomson-Houston Electric Company, has returned from a two months' trip in Colorado and New Mexico, where he did some excellent service.

Mr. Samuel Elder. long connected with the American Company in New England, leaves Boston this week for Pittsburgh, to accept a responsible position with the Short Electric Railway Company of that city. He is accompanied by the good wishes of many friends.

Mr. B. R. Pollock, the winner of the first prize in the recent telegraphers' tournament in New York, has received from the New Haven Clock Company a handsome French clock as a present. Mr. Pollock used in the tournament instruments that were manufactured by the New Haven company.

William E. Joyce, of Wilkes-Barre. Pa., one of the best known telegraphers of the State, has been employed by the Sprague Electric Railway and Motor Co. in their mines, mills, and water-power department, and will attend to the business of the company in the anthracite coal fields and contiguous counties.

A Happy Wedding.—Memphis, Tenn.—On the evening of April 17, Miss Jennie Thompson was united in marriage to Mr. F. E. Boardman, by Rev. Dr. Daniels. Miss Minnie Palmer acted as bridesmaid, and Mr. F. W. Thomas as groomsman. After the ceremony the bridal party were driven to the residence of the bride's parents, No. 47 Peyton avenue, where an elegant reception was tendered to them and their numerous friends, who complimented the hostess on the superb supper. The popularity of the young couple was attested by the many handsome presents they received, and the good wishes for their future prosperity voiced by a legion of friends. Miss Thompson was for several years assistant manager of the Memphis Telephone Exchange, and Mr. Boardman holds the position of Superintendent and Electrician of the Memphis Electric Light and Power Company.

MISCELLANEOUS NOTES.

Melbonrne, Australia.—The Thomson-Houston Electric Railway Company is building an electric street railway, which is in charge of Mr. Chauncy Belknap.

Telephone wires at Milwaukee are much affected by induction from the electric street railway wires, and the roar of the electric cars can be heard on the telephone to such an extent as to seriously interfere with its usefulness.

Aluminum Lamps.—The cheapening of aluminum has led to a proposition to construct arc lamps of this material. On account of its lightness and qualities of resisting rust it is vastly preferable to iron, steel, or brass for out-door use.

The Kahabeka Falls Land and Electric Light Company, Limited, has been organized at Toronto, Ont.; capital stock $800,000, in $100 shares. The promoters are: A. P. Boller, New York; E. D. Smith, Alexander McGan, E. V. Douglas, Philadelphia; W. P. Douglas, Minneapolis.

Shallenburg Alternating Current Meters.—The largest order for these meters was received by the Westinghouse Electric Company on April 16. The order is from the Metropolitan Manufacturing Company of London, Eng., and is for 750 meters. Recently 350 meters were ordered by the same company.

A somewhat curious correspondence has originated in the *Times* from a suggestion by Lord Bury, as a verb to express progression by electric power, of "to ohm" or "to volt." The following are among the new verbs suggested by various correspondents: To "motor," "to mote," to "electricize," to "electrize," "to electrate," "to tric," "to run," "to speed," "to watt," "to squirm," "to spark," "to gleam," 'to flash," "to coulomb," "to volice" or "volize," "to amber," and "to Bury."

Telephone Charges.—The Committee on Gas, Water and Electricity reported adversely Mr. Clarke's bill regulating telephone charges, and the report was agreed to by a vote of 80 to 20. The same committee then reported adversely Mr. Sullivan's bill relating to the Electrical Subway Company, of New York, and this report was also agreed to—yeas, 61; nays, 25. Adverse reports were made by the same committee on Mr Kerrigan's bill regulating telephone charges and Mr. Sullivan's bill on the same subject. These reports were agreed to.

The Pan-Electric Controversy.—A decision has been rendered in the suit of Rogers vs. Garland and others denying the plaintiff's right to an accounting, and declaring that defendants have throughout acted with integrity and good faith, the charges of fraud, perfidy and conspiracy set out in the bill not having been sustained in the proofs. The plaintiff is held entitled to a reconveyance of the patents not covered by the contracts between himself and the Pan-Electric Telephone and Telegraph Company; but each party is to pay his own costs, and on the whole the decision is in favor of the defendants.

The Westinghouse Electric Railway Company, has been duly organized with a capital stock of $2,500,000. The home office will be established in Pittsburgh, and branch offices opened in other commercial centres. Mr. H. McL. Harding, formerly general agent of the Sprague Electric Railway Company, and Mr. J. L. Barclay, will probably represent the company in Chicago. The Eastern branch will probably be placed in the hands of Mr. C. C. Warren, with headquarters in New York. The Westinghouse Company are to be congratulated on having secured such able representatives—men who have been identified with the progress of electric light and power since the inception of the business, the ability of each having been shown in the excellent commercial results obtained.

BUSINESS NOTICES.

Mr. Charles H. Cone, the Chicago representative of the Finlay Glass and Carbon Company, is nicely settled in his offices at 103 Adams street, and has secured some handsome orders for porcelain cut-outs and fuse blocks, as well as for open circuit batteries.

Ball Engines.—Mr. J. W. Parker, late with Messrs. H. M. Sciple & Co., of Philadelphia, has taken the agency of the Ball Engine Company, and has opened his office at 38 South Fourth street, Philadelphia. Mr. Parker has been selling the Ball engine for some years, and is well known to the trade.

Battery Cut-Out.—Attention is called to a simple device for disconnecting gas lighting batteries if accidentally grounded. It is cheap, sensitive, never needs watching, and has no clockwork to be kept wound. Terms furnished by the Electric Supply Company of Syracuse, N. Y., No. 105 South Warren street.

Jas. Schawel & Co., 29 John street, New York, importers and melters of platinum, was established in 1865 by Mr. Schawel, Sr., and has carried on a very successful business ever since. The increased demand for platinum has compelled them to extend their facilities. They offer special inducements to purchasers of scrap platinum. Their business is retail as well as wholesale.

Magnesia Boiler Covering.—Mr. Alfred C. Kemper, 208 Lake street, Chicago, has secured the contracts for covering with his "Magnesia sectional pipe and boiler covering," all the steam pipe surface in the extensive works of the Illinois Steel company at Joliet; the new Chamber of Commerce Safety Deposit company's building, Chicago; the Northwestern brewery and the American brewery; these in addition to many smaller plants.

Warning to Investors.—Suit against the United States Aluminum Metal Company, of New York, operating the so-called Herault process of electric smelting, has been begun by the Cowles Electric Smelting & Aluminum Company, of Cleveland, O. The alleged process of Herault is a gross infringement of the Cowles patents, and investors are hereby warned that we shall maintain these claims to the full extent of the law.

EUGENE H. COWLES, President.

A New Catalogue, $3 issue, sent us by the Mitchell-Vance Company, well illustrates their large variety of electric light and combination fixtures. The catalogue is really a handsome production, the lithographic process used in its pages showing up very distinctly the forms and appearances of the various styles of fixtures. The publishing of handsome catalogues is one of the many efficient methods adopted by enterprising houses to accomplish that necessity of the times—effective advertising.

W. C. Vosburgh Manufacturing Company, Limited, whose store and office is at 478 and 420 Fulton street, Brooklyn, was established in 1865 by W. C. Vosburgh & Co., who conducted its business until July 12, 1881, when it was duly incorporated under the laws of the State of New York, with a paid up capital of $150,000. The factory is at 273-281 State street, Brooklyn, where are employed 250 skilled workmen. Their stock of gas fixtures, electroliers, etc., is a beautiful one, and greatly facilitates the choice of one desiring to purchase. The company is progressive, and is constantly employing artists, both native and foreign, to design and model new ideas, which are beautifully produced in real or imitation bronze. The officers of the company are gentlemen widely and favorably known in business and social circles.

NEW YORK, April 7, 1890.

James H. Mason, Esq., 63 Broadway, N. Y.

DEAR SIR: It may be pleasing to learn what satisfaction your battery, which I have had in use all this spring, is giving.

The motor which it supplies is of the "Perret" type manufactured by the Elektron Manufacturing Company, and is driving a sewing machine. I am using three cells of the battery and they are amply sufficient to run the machine at a satisfactory speed. It has been in use more or less every day since it was set up and has been charged but once. There is no perceptible slacking off in efficiency as yet, and no disagreeable fumes.

I am very much pleased with the battery and am gratified to know that a successful commercial primary battery is on the market.

Respectfully yours, WM. A. ROSENBAUM.

NEW YORK, April 25, 1890.

Messrs. J. Ullrich & Co., 106, 108 Liberty St., New York City:

GENTLEMEN: At the fast telegraphing tournament held in this city April 10 last, I was one of those entered to compete for the prize offered for the best pen and ink copy of Mr. Waugh's transmission. Knowing that it would be quite impossible for me to keep up with the high-speed sending if I used an ordinary pen, I decided to try a fountain pen, which would overcome the necessity of having to dip into an ink bottle. I purchased one of your Star Fountain pens for the purpose, and it carried me through the ordeal without any trouble. I copied 229 words in 5 minutes with it, and I found it so convenient that I have been using nothing else since, not even a lead pencil. I had never tried a fountain pen before, but now every other method of writing has practically been abandoned for your fountain pen. It is a real time and labor saver.

Very truly yours,

THOMAS R. TALTAVALL,
Editor *Electric Age.*

Mr. Taltavall won the $20 prize offered by Messrs. A. B. Chandler and Fred Catlin at the fast-sending telegraphers' tournament, April 10, 1890, for the finest high-speed writing the judges had ever seen.

OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS.

PATENTS ISSUED APRIL 22, 1890.

425,921. Electric Motor; Frank E. Davis, of Boston, and John Scott, Jr., of Plymouth, Mass. Application filed Nov. 19, 1889. A plurality of electric motors having all their armatures in the same circuit in combination with the switch in the circuit, automatic means for operating the switch to successively insert resistances in the circuit, break the circuit, and short circuit the armatures, and automatic means for releasing the switch to permit it to be operated by the first named means.

425,995. Electric Fan; Philip Diehl, of Elizabeth, N. J. Application filed Sept. 24, 1889. The combination, with the column or standard, of the vertically adjustable post supported thereby, a frame or casing, an electric motor and rotary fan sustained by the casing or frame, and a counterbalance for the post, frame or casing, motor and fan.

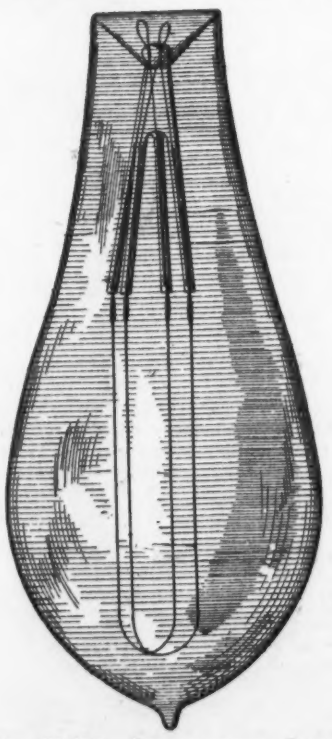
425,999. Process of Manufacturing Electrodes for Secondary Batteries; Ludwig Epstein, of Berlin, Germany. Application filed May 31, 1889. The process of manufacturing electrodes for electric accumulators, which consists in first boiling the lead plates in weak acidulated water, then drying the plates, then subjecting them to the positive primary electric current, and finally subjecting the positive electrodes thus produced to the negative primary electric current.

426,009. Bell and Engine Indicator for Pilot Houses of Steam Vessels; William E. Hadlock, of Wenham, Mass. Application filed December 4, 1888. An indicating apparatus for steam vessels, comprising a circuit connecting the engine-room and the pilot house, a transmitter operated by the shaft or other moving part of the engine and connected by the circuits with an indicating instrument in the pilot house, a switch controlling the circuits, and a bell pull in the pilot house for operating a bell in the engine-house, the said switch being in the path of the bell pull, whereby the circuits are placed in operative condition when the bell pull is operated.

426,024. Magnetic Circuit Closer; John Von Der Kamer, of New York, N. Y., Assignor of one-half to James Ward Packard, of same place. Application filed April 25, 1889. In an automatic circuit closer for shunt circuits, the spring-operated magnet, which forms one terminal of the open shunt circuit, in combination with the other terminal and any suitably arranged piece of fusible material which holds the spring-operated magnet normally out of contact with the other terminal.

426,049. Electric Switch; James P. Norton, of Detroit Mich., Assignor to the Detroit Electrical Works, of same place. Application filed Feb. 20, 1890. In an electric switch, a cam and an elliptic spring embracing the cam, and co-operating contacts controlled by the spring and cam.

426,055. Incandescent Electric Lamp; James Ward Packard, of New York, N. Y., Assignor to the Westinghouse Electric Company, of Pennsylvania. Application filed Dec 7, 1889. In an incandescent electric lamp a stock for supporting the electrodes of the lamp, which consists of the solid central stem of such size that it can be joined to the base of the lamp by a flat seal, combined with four or more tubular branches from the solid central stem, together with the platinum electrodes imbedded in the solid stem, and the copper extensions to the same, located in the tubular branches.



NO. 426,055.—INCANDESCENT LAMP.

426,057. Fuse-Block; Thomas Patterson, of Boston, Mass. Application filed December 30, 1889. A block having one or more grooves or passages lined with asbestos paper, combined with a fuse wire placed in the groove or passage, and a spring for holding it taut, and a lined cover for the block, which conceals the fuse wire and spring within the groove.

426,064. Insulating Hanger for Overhead Supply Conductors; Frank B. Rae, of Detroit, Mich. Application filed November 14, 1889. An insulating hanger consisting of a bell-shaped insulator having a metal hanger secured to project to its under side and to support the conductor, and having suspended arms secured to the exterior of the insulator and extending upward.

426,065. Current Indicator; Frank B. Rae, of Detroit, Mich. Application filed Jan. 14, 1890. A current indicator consisting of an electro-magnet, the coils of which are included in the circuit to be measured, a semi-circular core piece tapered from its base to its free end, a plate connected to the base and extending toward the free end of the core piece, an armature pivoted to the plate and carrying a ring-shaped piece of soft iron embracing the core piece, and an indicator attached thereto.

426,066. Trolley Support; Frank B. Rae, of Detroit, Mich. Application filed Feb. 4, 1890. The combination with the base piece having flanges, with a central socket having recessed lower ends of a headed steam fitting the socket, a standard secured to the stem, the said standard carrying pivoted socket for the trolley arm, and means for adjusting the pressure of the arm upon the conductor.

426,082. Safety Connection; Elihu Thomson, of Lynn, Mass. Application filed Aug. 5, 1889. The combination, with a local or independent circuit or conductor liable to accidental connection with a high-tension conductor, of a safety ground connection formed by wires or conductors adapted to carry the current of the high-tension circuit without interruption, such safety ground connection having interposed in its two contacts or electrodes separated from each other by a narrow insulating film, across which the high tension may force its way.

426,102. Electric Railway Contact; Francis O. Blackwell, of New York, N. Y., Assignor to the Thomson-Houston Electric Company, of Connecticut. Application filed July 23, 1889. The combination in an electric railway, with a suspended line conductor and an electrically propelled vehicle, of a contact device consisting of a rod or support extending upward from the vehicle and movable upward and toward and away from the conductor, and a contact-making piece carried upon the support, but having an independent lateral movement relatively thereto.

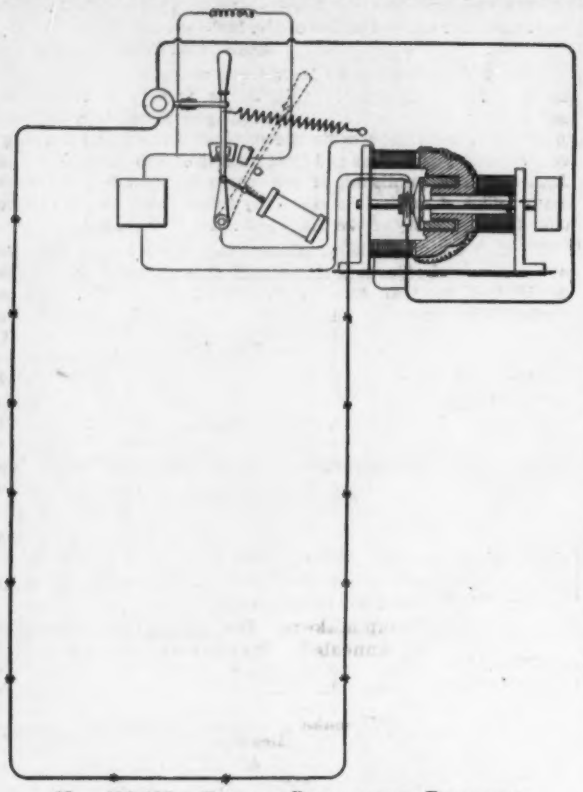
426,108. Safety Device for Dynamos; Ernest P. Clark, of New York, N. Y., Assignor to the Clark Electric Company of same place. Application filed Dec. 30, 1889. The combination with a shunt wound constant current dynamo, of a make and break switch located in its field magnet circuit, and in its main circuit an electro-magnetic device for holding the switch in its closed position, and means for opening the switch when it has been released by the electro-magnet.

(1) 426,109. (2) 426,110. Safety Device for Dynamos; Ernest P Clark, of New York, N. Y., Assignor to the Clark Electric Company, of same place. Applications filed (1) Dec. 30, 1889, and (2) Jan. 13, 1890. A safety device for dynamo electric machines, consisting of a magnet in the main circuit, a shunt circuit around the field coils of the machine, and a circuit closer in the shunt circuit controlled by the magnet, said circuit closer consisting of a spring operated switch arm, a latch for holding the arm in its open position, the latch being operated by the magnet, and a terminal into contact with which the arm is to be forced by the spring when it is released by the latch. (2) In an automatic safety device for alternating current dynamos, the combination of a circuit controller governing the exciting current of the dynamo, an electro magnet located in the alternating current circuit, an armature lever positively locking the circuit controller and a spring tender to move the circuit controller when the said armature lever is released, whereby the exciting current of the

dynamo shall be broken and cease when the alternate current ceaces or is interrupted.

426,121. Insulated Joint; Emil F Gennert, of New York, N. Y. Application filed March 22, 1889. In fixtures for electric lighting; a joint consisting of two nipples, having radial flanges on their adjacent ends; a washer of insulating material interposed between the flanges, washers of insulating material, of larger diameter than the flanges, placed one each on the outside of the flanges, two casing rings, inclosing the washers and flanges, and screw bolts for securing the casing rings together.

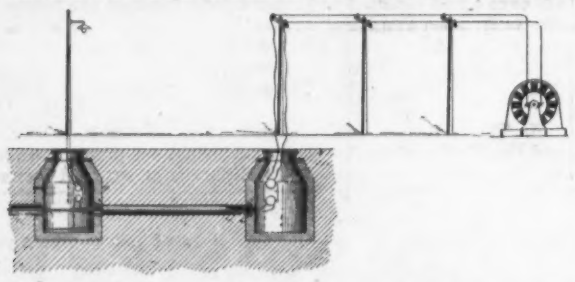
426,127. System of Electrical Distribution; Charles J. Kintner, of New York, N. Y. Application filed Dec. 20, 1889. The method of distributing electricity, consisting in generating low tension currents and conducting the low tension currents to a point below the earth's surface and then converting them into



No. 426,108.—Safety Device for Dynamos.

high tension currents and conducting the high tension currents to outlying points through conductors located entirely beneath the earth's surface, and then converting the high tension currents again into low tension currents, and finally conducting the same to the consumers.

426,134. Electric Signaling Apparatus for Hotels; John J. Miller, of Cleveland, Ohio, Assignor to James P. Langley, of East Saginaw, Mich. Application filed February 15, 1889. The combination, with a single line for each room, two trunk lines constituting a common return, the annunciator bell on one of the trunk lines, room bells, and annunciator drops or indicators on each room line and the two point push buttons or keys for each of the room lines of a clock having a series of terminals and connected with time and room strips, as described, and a two point push button or key connected with the clock mechanism and normally in the office annunciator circuit, the clock mechanism

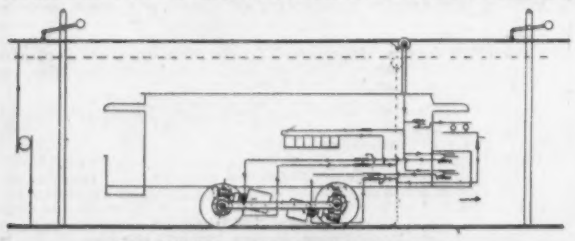


No. 426,127.—System of Electrical Distribution.

adapted at stated intervals and for a short period to break the key from its normal contact and connect it with the roo bell circuit.

426,153. Converter; Edmund Wagemann, of Little Rock, Ark., Assignor of six-sevenths to John D. Adams, Dean Adams, Oscar Davis, John W. Davis, Horace G. Allis, and John B. Jones, all of same place. Application filed Aug. 22, 1889. An electric converter consisting of the combination of a secondary coil, and a primary conductor consisting of superposed plates of copper and iron arranged alternately with one another and surrounded by the secondary coil, the axis of the said coil being perpendicular to the planes of the said plates.

426,156. Fuse Block; Frederick G. Warrell, of Philadelphia, Pa. Application filed February 3, 1890. In an electric cut out a solid base having secured thereon two ends of the electric conducting wire, said ends connected by fusible conducting connection, in combination with a sliding porcelain shell or casing surrounding



No. 426,382.—Electric Railway.

said base and parts thereof, said shell adapted to slide on the said solid base, exposing the same and parts connected therewith, in order to allow of an examination of the parts of the cut-out and to renew a burned out fuse and insure a perfect contact before replacing the sliding shell.

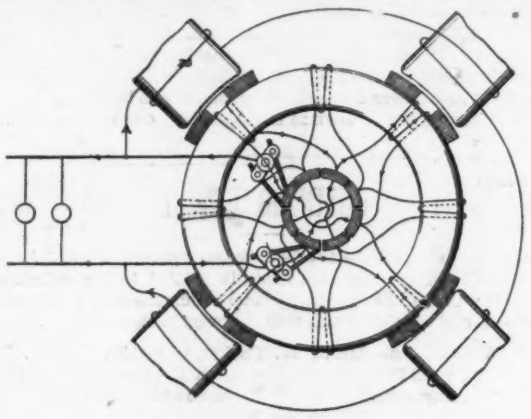
426,189. Holder for Incandescent Electric Lamps; Philip H. Klein, Jr., of New York, N. Y., Assignor to the Bergmann Electric & Gas Fixture Company, of same place. Application filed Sept. 5, 1889. The invention consists in a metal arm having one end provided with a clamping ring, and the opposite end with a clamping ring and the opposite end with a threaded portion to engage an electric lamp.

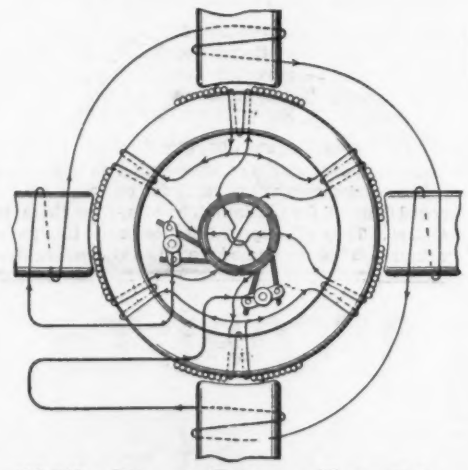
(1 426,196. Apparatus for Hauling Through Electric Cables; (2) 426,197. Underground Conduit; (3) 426,198. Insulator; (4) 426,199. Duct for Electric Conductors; James F. Munsie, of Brooklyn, N Y., Assignor to Thomas Leonard Coles, of same place. Applications filed (1) and (2), May 8, 1889; (3) and (4), Oct. 29, 1889. (1) The combination, with a main conduit, for electrical conductors, of a branch conduit and a traveling grapple or hook located within the branch conduit and a way for supporting the grapple or hook during its forward and backward movements. (2) An underground conduit consisting of a series of isolated sections, each section extending from one man-hole to an adjacent man-hole in the system, and provided with ducts containing electrical conductors extending through the opposite ends of the ducts, the ducts being hermetically sealed at both ends, and provided with taps for the attachment of an exhaust pump. (3) In an overhead system of electrical conductors, the combination, with a pole or standard and its cross arms, of clamping devices for the conductors, secured to the cross arms, and consisting of two parts or sections having serrated edges and lined with a soft yielding material, the material having side flanges resting between the said serrated edges. (4) An electric wire duct consisting of concentric tubes having an intermediate filling of powdered fire-resisting material.

426,200. Flexible Connector; James F. Munsie, of Brooklyn, N. Y., Assignor to Thomas Leonard Coles, of same place. Application filed Oct. 30, 1889. A connector for electric circuits consisting of a flexible body portion, containing a group or assembly of small wires spread out at their ends, end plates between which the spread ends of the wires are clamped, the end plates being provided with spring fingers, a metallic casing for receiving the spring fingers, and an insulated casing surrounding the metallic casing.

426,201. Insulating Lining; James F. Munsie, of Brooklyn, N. Y., Assignor to Thomas L. Coles, of New York. Application filed January 17, 1890. A removable sectional lining for electrical conduits, consisting of a series of sections of insulating material fitting within the inner walls of the conduit and movable through the conduit from end to end, the sections being provided with hollow interiors communicating with each other and forming a continuous passage way for the insertion and withdrawal of the electrical conductor.

(1) 426,203. Insulator; (2) 426,204. Binding Post; (3) 426,205. Duct for Electric Conductors; James F. Munsie, of Brooklyn, Assignor to Thomas L. Coles, of New York, N. Y. Applications filed January 17, 1890. (1) In an overhead system of electric conductors, the combination, with a supporting piece for the line wire, of a cap piece therefor, both pieces having tapering ends, and internally screw threaded clamping sleeves fitting over the ends and adapted to draw the cap piece down toward the bed piece so as to clamp the line wire between them, the clamping sleeves being of harder material than the tapering ends, so as to cut a screw thread upon the latter during the clamping operation. (2) A distributing device for electrical conductors, consisting of a base of conducting material adapted to be connected to the line wire, and a series of screw plugs of conducting material fitting one within the other and adapted to clamp distributing wires between them an outer screw plug of insulating material and a cap screw for clamping dead wires to the insulating screw plug. (3) A duct or conduit for electrical conductors, consisting of concentric pipes, having an intervening filling, in combination with a sleeve serving to fill the





No. 426,348.—Dynamo Electric Machine.

ends of the intervening spaces in adjacent duct sections and provided with an inner flange and an outer flange.

426,206. Man-Hole for Underground Electric Conduits; James F. Munsie, of Brooklyn, Assignor to Thomas L. Coles, of New York, N. Y. Application filed Jan. 22, 1890. A man-hole for underground electric conduits, having low-tension or battery wires passing through its upper portion and high-tension or electric light wires passing through its lower portion, in combination with a parallel conductor interposed between the two sets of wires to neutralize or minimize the effect of induced currents.

426,222. Electric Railway Signal; George Armes Tower, of Richmond, Va. Application filed June 14, 1889. In a railway signal, the combination of a plate, the spring actuated rod sliding in suitable keepers of the plate and designed to be connected with the whistle of a locomotive, locking bolts sliding in suitable ways and provided with an opening and capable of movement to bring the opening opposite the end of the bolt, and a bar arranged beneath the locking bolt and operating the same.

426,247. Electro-Magnetic Instrument; Patrick J. Delaney, of South Orange, N. J. Application filed Jan. 30, 1890. The combination, with an electro-magnet, its vibrating armature, lever armature, lever spring, and means for gradually adjusting the spring, of a stop for limiting the straining of the spring.

426,266. Coin-Operated Apparatus for Telephones; William Gray, of Hartford, Conn., Assignor of one-half to Charles Soby, of same place. Application filed Aug. 12, 1889. In combination with a telephone apparatus, a signal device, a lever having an arm interposed between the signal and its tappet, and controlled levers for moving the interposed arm from between the signal and the tappet.

426,304. Thermostat; John P. McMahon, of Buffalo, N. Y., Assignor to the McMahon Thermograph Co., of Jersey City, N. J. Application filed Oct. 7, 1889. The combination of a case, a tube formed with threads to engage said case and to be held against movement, a disc secured to the tube with fusible solder, fixed contact points, and two independent spring contact points, forming the terminals of two different electrical circuits, and an insulated post adapted to rest against said disc and to engage both of the spring contacts and hold them against the spring pressure.

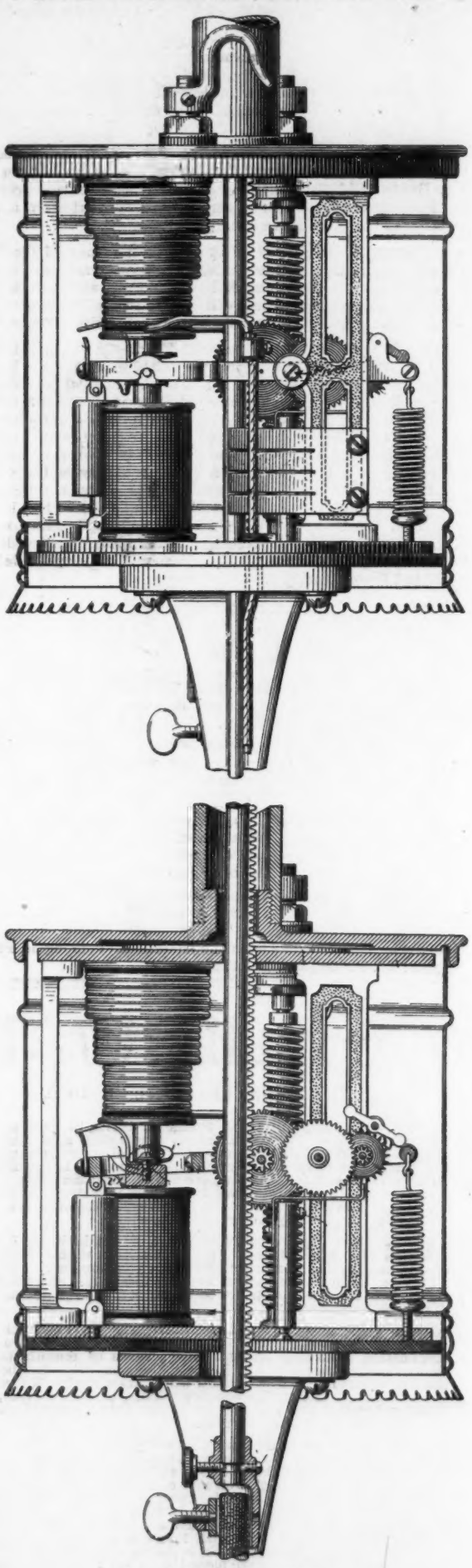
426,348. Dynamo Electric Machine; Merle J. Wightman and Elihu Thomson, of Lynn, Mass., Assignors to the Thomson-Houston Electric Company, of Connecticut. Application filed Sept. 17, 1888. The combination, in a self-exciting alternating current dynamo, of alternating coils made up of ribbons of magnetic metal suitably insulated from each other, arranged upon the exterior of the armature, and self-exciting coils wound around the core of the armature and between the alternating coils.

426,379. Electric Railway Car; John C. Henry, of Kansas City, Mo. Application filed July 5, 1887. In electric railways, the combination with a subway conduit provided with slot-rails and a slot between the rails, of a generator and a series of electric conductors alternating in polarity, and connected in pairs to the opposite poles of the generator, supported in tiers, and having the lower conductors in the series the return conductors.

426,380. Electric Motor and Dynamo; John C. Henry, of New York, N. Y. Application filed Sept. 5, 1889. In a motor or dynamo the combination of two or more armatures which act reciprocally as fields to each other, and are all geared to a single shaft or axle, which is exterior to and symmetrically located between them.

426,381. Electric Gas Lighter; Charles S. Hinds, of New York, N. Y. Application filed August 29, 1889. The combination with a burner having an insulated electrode and a conductor, of a pivoted swinging lever carrying an electrode which swings in the arc of a circle with said lever, and a contact arm also swinging in the arc of a circle with the lever making contact with the conductor in the swinging movement of the lever to swing its electrode into contact with the electrode on the burner.

426,395. Apparatus for Electric Railway Signaling; Charles H. Rudd, of Evanston, Ill., Assignor of one-half to James W. White, James Clarence White and Henry M. Lewis, trustees, of Philadelphia, Pa. Application filed Oct. 28, 1889. The invention consists in using a track composed of three rails, insulated



No. 426,405.—Arc Lamp.

from each other, one of which rails acts as an conductor for the propelling current, which passes through the motor and then returns to the generator through the other two rails, being alternately and automatically shifted from one to the other while passing through the motor, and actuating suitable recording mechanism to indicate at the controlling station the speed and location of the locomotive.

426,405. Arc Lamps; James J. Wood, of Brooklyn, N. Y., Application filed Nov. 8, 1889. In an arc lamp, the combination, with a carbon holder having rack teeth and feeding train for feeding down the holder, including a feeding pinion engaging with the rack and a retarding device for governing the rate of feed, of a friction clutch interposed between the pinion and retarding device for governing the rate of feed, of a friction clutch interposed between the pinion and retarding device, whereby when the carbon holder is forcibly pulled down the said clutch will slip and avoid injury to the feeding train.

Copies the specifications and drawings complete of any of the patents mentioned in this record—or of any other patents issued since 1866—can be had for 25 cents. Give date and number, and address The W. J. Johnston Co. Ltd., Times Building, N. Y.